DOUBLE ISSUE

SEPTEMBER 23, 2019

TIME

SPECIAL CLIMATE ISSUE

2050: HOW EARTH SURVIVED

by BILL MCKIBBEN

PLUS

AL GORE
BARBARA KINGSOLVER
ANGELINA JOLIE
JANE GOODALL
GRAÇA MACHEL
ANNE HIDALGO
& MORE

AMAZON ON THE BRINK

AFRICA'S GREAT GREEN WALL

THE HOTTEST CITY ON EARTH

This cover image, measuring 98 ft. by 65 ft., was created in sand east of Tokyo

TIME
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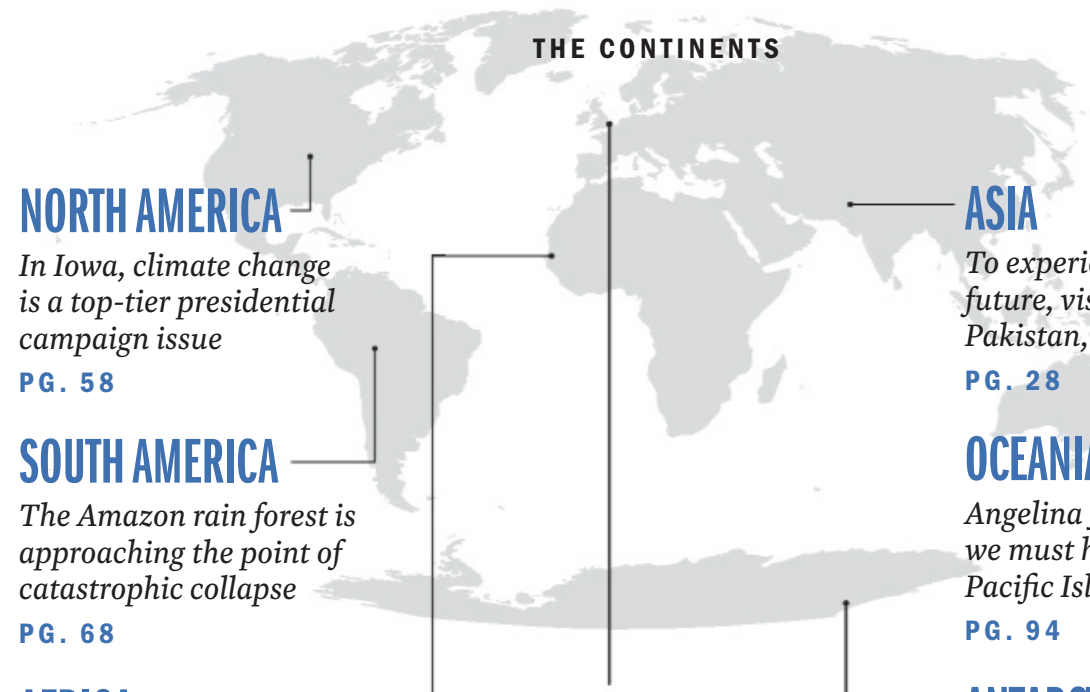

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Photograph by Sebastián Liste—NOOR for TIME

COVER DRONE PHOTOGRAPHY BY TETSUYA TAKANO

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The sands of TIME

THIS ISSUE, IF CIVILIZATION can get its act together, might just mark a midpoint in TIME's coverage of the biggest crisis facing our planet.

Three decades ago—at a moment when much of the world was only beginning to wake up to the damage humanity had been wreaking on its home—TIME convened a group of 33 scientists and political leaders from five continents in Boulder, Colo., to discuss the threat. The result was one of the best-known issues TIME has ever produced, sounding one of the louder alarms to date. In the Jan. 2, 1989, issue, the editors named "Endangered Earth" the most important story of the year, replacing the annual "Person of the Year" with a planet, our own. The cover, by the artist Christo, showed a 16-in. globe wrapped in plastic and rag rope.

Three decades from now, we will be on the cusp of 2050, the year by which we must have already acted—with urgency as outlined by the U.N.'s Intergovernmental Panel on Climate Change—to have any chance of keeping average global warming to 1.5°C above 19th century levels. That is the line above which scientists agree that the effects of climate change—extreme weather, rising seas, wildfires, a deepening refugee crisis—will be even more disastrous.

Human nature, like journalism, is deadline-oriented. Our intent with this issue—only the fifth time in our history that we have turned over every page of a regular issue, front to back, to a single topic—is to send a clear message: we need to act fast, and we can. As TIME did 30 years ago, we've assembled some of the world's most influential voices on climate to lay a path forward, from former Vice President Al Gore (who also contributed to the 1989 issue) to the African activist Graça Machel to Chinese environmentalist Ma Jun.

WE ALSO EXPLORE the essential role of innovation in solving the crisis. And there is deep reporting from every continent on the planet. Correspondent Matt Sandy journeyed thousands of miles by road, boat and small plane to the front lines of Amazon deforestation. Cape Town–based Aryn Baker visited the Great Green Wall of Africa, an $8 billion agricultural project to transform the lives of millions of people living on another major climate-change front. Aryn also ventured to one of the hottest cities on earth: Jacobabad, Pakistan, where summer temperatures regularly exceed 122°F.

Earth as Planet of the Year—the Jan. 2, 1989, issue—at top, and this week's cover, below

At TIME.com/2050, you can download an immersive 3-D journey into the Amazon narrated by famed conservationist Jane Goodall, and see what it's like to be in Pakistan in the middle of a deadly summer heat wave. We hope you will also sign up for our new newsletter, One.Five, from TIME climate correspondent Justin Worland; it will explore the interconnectedness of climate with other major issues and track progress against the U.N.'s 2050 goals. And TIME will be hosting two major summits in New York this fall, with climate high on both agendas.

Notably, what you will not find in this issue are climate-change skeptics. Core to our mission is bringing together diverse perspectives. Experts can and should debate the best route to mitigating the effects of climate change, but there is no serious doubt that those effects are real. We are witnessing them right in front of us. The science on global warming is settled. There isn't another side, and there isn't another moment.

It is a moment we can rise to—and that is the message of the cover of this issue, a sand sculpture created on the shores east of Tokyo by the Japanese artist Toshihiko Hosaka and photographed by drone. Like the shared work of mitigating climate change, Hosaka's cover is the result of collective action—a seven-person team worked together for 14 days, dodging a typhoon along the way, to create a visual statement out of the earth itself.

Edward Felsenthal,
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Behind the cover

THREE DECADES AGO, TIME named earth "Planet of the Year" for 1988, featuring a cover by the artist Christo of the earth encased in plastic on a beach in Long Island in New York. For this week's special-issue cover on climate change, TIME returned to sand—albeit this time on the shores east of Tokyo.

Japanese sand sculptor Toshihiko Hosaka and his seven-person team spent 14 days creating the 98-ft.-by-65-ft. TIME cover on the site of the former playground at Iioka Junior High School in Iioka, Asahi. The school, walking distance from the Pacific, closed after the East Japan earthquake and tsunami in 2011. The challenges Hosaka would encounter flowed from the slower, but no less deadly, changes the cover warns about.

"The biggest enemy of my work is the heat," says Hosaka, who started building the sculpture on Aug. 9, when temperatures hit 96°F. "I have been making sand sculptures for over 20 years, and most of my work is outdoors. The heat has increased compared to before."

Hosaka spent one day preparing the ground and two days laying out the design. The sculpture process involves raking the sand for eight hours a day, which the team did for seven days, followed by two days of fine adjustments. The entire cover was then photographed with a Phantom 4 Pro drone camera shooting 4K video.

It took two weeks of work by sand artist Toshihiko Hosaka and his team to sculpt the design that appears on the cover of this week's special issue

"We sculpt letters, frames and earth parts using shovels, forks and rakes used for gardening," says Hosaka, who studied sculpture at what was then the Tokyo National University of Fine Arts and Music. "It was necessary to always moisten because if the ground was dry, it did not form. It is a huge work. I carved it a little and shot it with a drone to adjust the balance and depth. A dust spray is sprayed thinly on the finished part. This spray is used for road construction. This will withstand some rain and dryness."

The typhoon that swept across Japan in mid-August carried more than "some rain," however. With climate change, extremes in weather have grown more intense and frequent across the globe, and Typhoon Krosa could have erased the image Hosaka and his team had labored over for two weeks. "We were all worried," the artist recalls. "But the course changed a little, and we were able to avoid a direct hit." —D.W. PINE

TIME'S NEWEST NEWSLETTER

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TIME

The Fight *For Earth*

Human-made climate change has thrown civilization headfirst into a global crisis, and time is growing short. Survival on the planet requires systematic changes to our economies, our geopolitics and our cultures. Thirty years from now, we'll look back at 2019 as an inflection point. Whether good or bad is up to us.

ILLUSTRATION BY JING ZHANG FOR TIME

2050

HOW WE *Survived* CLIMATE CHANGE

It's 2050.
The world has changed forever,
but we averted the worst.
Here's what we did

By Bill McKibben

Illustrations by David Doran for TIME

LET'S IMAGINE FOR A MOMENT THAT WE'VE reached the middle of the century. It's 2050, and we have a moment to reflect—the climate fight remains the consuming battle of our age, but its most intense phase may be in our rearview mirror. And so we can look back to see how we might have managed to dramatically change our society and economy. We had no other choice.

There was a point after 2020 when we began to collectively realize a few basic things.

One, we weren't getting out of this unscathed. Climate change, even in its early stages, had begun to hurt: watching a California city literally called Paradise turn into hell inside of two hours made it clear that all Americans were at risk. When you breathe wildfire smoke half the summer in your Silicon Valley fortress, or struggle to find insurance for your Florida beach house, doubt creeps in even for those who imagined they were immune.

Two, there were actually some solutions. By 2020, renewable energy was the cheapest way to generate electricity around the planet—in fact, the cheapest way there ever had been. The engineers had done their job, taking sun and wind from quirky backyard DIY projects to cutting-edge technology. Batteries had plummeted down the same cost curve as renewable energy, so the fact that the sun went down at night no longer mattered quite so much—you could store its rays to use later.

And the third realization? People began to understand that the biggest reason we weren't making full, fast use of these new technologies was the political power of the fossil-fuel industry. Investigative journalists had exposed its three-decade campaign of denial and disinformation, and attorneys general and plaintiffs' lawyers were beginning to pick them apart. And just in time.

When we look back to the start of the century we are, of course, angry that people did so little to slow the great heating

THESE TRENDS FIRST INTERSECTED powerfully on Election Day in 2020. The Halloween hurricane that crashed into the Gulf didn't just take hundreds of lives and thousands of homes; it revealed a political seam that had begun to show up in polling data a year or two before. Of all the issues that made suburban Americans—women especially—uneasy about President Trump, his stance on climate change was near the top. What had seemed a modest lead for the Democratic challenger widened during the last week of the campaign as damage reports from Louisiana and Mississippi rolled in; on election night it turned into a rout, and the analysts insisted that an underappreciated "green vote" had played a vital part—after all, actual green parties in Canada, the U.K. and much of continental Europe were also outperforming expectations. Young voters were turning out in record numbers: the Greta Generation, as punsters were calling them, made climate change their No. 1 issue.

And when the new President took the oath of office, she didn't disappoint. In her Inaugural Address, she pledged to immediately put America back in the Paris Agreement—but then she added, "We know by now that Paris is nowhere near enough. Even if all the countries followed all the promises made in that accord, the temperature would still rise more than 3°C (5°F or 6°F). If we let the planet warm that much, we won't be able to have civilizations like the ones we're used to. So we're going to make the changes we need to make, and we're going to make them fast."

Fast, of course, is a word that doesn't really apply to Capitol Hill or most of the world's other Congresses, Parliaments and Central Committees. It took constant demonstrations from ever larger groups like Extinction Rebellion, and led by young activists especially from the communities suffering the most, to ensure that politicians feared an angry electorate more than an angry carbon lobby. But America, which historically had poured more carbon into the atmosphere than any other nation, did cease blocking progress. With the filibuster removed, the Senate passed—by the narrowest of margins—one bill after another to end subsidies for coal and gas and oil companies, began to tax the carbon they produced, and acted on the basic principles of the Green New Deal: funding the rapid deployment of solar panels and wind turbines, guaranteeing federal jobs for anyone who wanted that work, and putting an end to drilling and mining on federal lands.

Since those public lands trailed only China, the U.S., India and Russia as a source of carbon, that was a big deal. Its biggest impact was on Wall Street, where investors began to treat fossil-fuel stocks with increasing disdain. When BlackRock, the biggest money manager in the world, cleaned its basic passive index fund of coal, oil and gas stocks, the companies were essentially rendered off-limits to normal

BACKGROUND PHOTOS: GETTY IMAGES (4)

investors. As protesters began cutting up their Chase bank cards, the biggest lender to the fossil-fuel industry suddenly decided green investments made more sense. Even the staid insurance industry began refusing to underwrite new oil and gas pipelines—and shorn of its easy access to capital, the industry was also shorn of much of its political influence. Every quarter meant fewer voters who mined coal and more who installed solar panels, and that made political change even easier.

As America's new leaders began trying to mend fences with other nations, climate action proved to be a crucial way to rebuild diplomatic trust. China and India had their own reasons for wanting swift action—mostly, the fact that smog-choked cities and ever deadlier heat waves were undermining the stability of the ruling regimes. When Beijing announced that its Belt and Road Initiative would run on renewable energy, not coal, the energy future of much of Asia changed overnight. When India started mandating electric cars and scooters for urban areas, the future of the internal-combustion engine was largely sealed. Teslas continued to attract upscale Americans, but the real numbers came from lower-priced electric cars pouring out of Asian factories. That was enough to finally convince even Detroit that a seismic shift was under way: when the first generation of Ford E-150 pickups debuted, with ads demonstrating their unmatched torque by showing them towing a million-pound locomotive, only the most unreconstructed motorheads were still insisting on the superiority of gas-powered rides.

Other easy technological gains came in our homes. After a century of keeping a tank of oil or gas in the basement for heating, people quickly discovered the appeal of air-source heat pumps, which turned the heat of the outdoors (even on those rare days when the temperature still dropped below zero) into comfortable indoor air. Gas burners gave way to induction cooktops. The last incandescent bulbs were in museums, and even most of the compact fluorescents had been long since replaced by LEDs. Electricity demand was up—but when people plugged in their electric vehicles at night, the ever growing fleet increasingly acted like a vast battery, smoothing out the curves as the wind dropped or the sun clouded. Some people stopped eating meat, and lots and lots of people ate less of it—a cultural transformation made easier by the fact that Impossible Burgers turned out to be at least as juicy as the pucks that fast-food chains had been slinging for years. The number of cows on the world's farms started to drop, and with them the source of perhaps a fifth of emissions. More crucially, new diets reduced the pressure to cut down the remaining tropical rain forests to make way for grazing land.

In other words, the low-hanging fruit was quickly plucked, and the pluckers were well paid. Perhaps the fastest-growing business on the planet involved third-party firms that would retrofit a factory or an office with energy-efficient technology and simply take a cut of the savings on the monthly electric bill. Small businesses, and rural communities, began to notice the economic advantages of keeping the money paid for power relatively close to home instead of shipping it off to Houston or Riyadh. The world had wasted so much energy that much of the early work was easy, like losing weight by getting your hair cut.

$5.2 trillion

Amount that the IMF estimates fossil fuels received in subsides—including the cost of pollution to your health—in 2017

2.9 gigatonnes

Amount of greenhouse-gas emissions from worldwide beef production annually; 14.5% of all emissions come from livestock

$10 trillion

Potential savings per year by the end of the century for the U.S. in key sectors if warming is kept to 3°C rather than the currently projected 5°C

BUT THE EARLY EUPHORIA came to an end pretty quickly. By the end of the 2020s, it became clear we would have to pay the price of delaying action for decades.

For one thing, the cuts in emissions that scientists prescribed were almost impossibly deep. "If you'd started in 1990 when we first warned you, the job was manageable: you could have cut carbon a percent or two a year," one eminent physicist explained. "But waiting 30 years turned a bunny slope into a black diamond." As usual, the easy "solutions" turned out to be no help at all: fracked natural-gas wells were leaking vast quantities of methane into the atmosphere, and "biomass burning"—cutting down forests to burn them for electricity—was putting a pulse of carbon into the air at precisely the wrong moment. (As it happened, the math showed letting trees stand was crucial for pulling carbon from the atmosphere—when secondary forests were allowed to grow, they sucked up a third or more of the excess carbon humanity was producing.) Environmentalists learned they needed to make some compromises, and so most of America's aging nuclear reactors were left online past their decommissioning dates: that lower-carbon power supplemented the surging renewable industry in the early years, even as researchers continued work to see if fusion power, thorium reactors or some other advanced design could work.

The real problem, though, was that climate change itself kept accelerating, even as the world began trying to turn its energy and agriculture systems around. The giant slug of carbon that the world had put into the atmosphere—more since 1990 than in all of human history before—acted like a time-delayed fuse, and the temperature just kept rising. Worse, it appeared that scientists had systematically underestimated just how much damage each tenth of a degree would actually do, a point underscored in 2032 when a behemoth slice of the West Antarctic ice sheet slid majestically into the southern ocean, and all of a sudden the rise in sea level was being measured in feet, not inches. (Nothing, it turned out, could move Americans to embrace the metric system.) And the heating kept triggering feedback loops that in turn accelerated the heating: ever larger wildfires, for instance, kept pushing ever more carbon into the air, and their smoke blackened

ice sheets that in turn melted even faster.

This hotter world produced an ongoing spate of emergencies: "forest-fire season" was now essentially year-round, and the warmer ocean kept hurricanes and typhoons boiling months past the old norms. And sometimes the damage was novel: ancient carcasses kept emerging from the melting permafrost of the north, and with them germs from illnesses long thought extinct. But the greatest crises were the slower, more inexorable ones: the ongoing drought and desertification was forcing huge numbers of Africans, Asians and Central Americans to move; in many places, the heat waves had literally become unbearable, with nighttime temperatures staying above 100°F and outdoor work all but impossible for weeks and months at a time. On low-lying ground like the Mekong Delta, the rising ocean salted fields essential to supplying the world with rice. The U.N. had long ago estimated the century could see a billion climate refugees, and it was beginning to appear it was unnervingly correct. What could the rich countries say? These were people who hadn't caused the crisis now devouring their lives, and there weren't enough walls and cages to keep them at bay, so the migrations kept roiling the politics of the planet.

There were, in fact, two possible ways forward. The most obvious path was a constant competition between nations and individuals to see who could thrive in this new climate regime, with luckier places turning themselves into fortresses above the flood. Indeed some people in some places tried to cling to old notions: plug in some solar panels and they could somehow return to a more naive world, where economic expansion was still the goal of every government.

But there was a second response that carried the day in most countries, as growing numbers of people came to understand that the ground beneath our feet had truly shifted. If the economy was the lens through which we'd viewed the world for a century, now survival was the only sensible basis on which to make decisions. Those decisions targeted not just carbon dioxide; these societies went after the wild inequality that also marked the age. The Green New Deal turned out to be everything the Koch brothers had most feared when it was introduced: a tool to make America a fairer, healthier, better-educated place. It was emulated around the world, just as America's Clean Air Act had long served as a template for laws across the globe. Slowly both the Keeling Curve, measuring carbon in the atmosphere, and the Gini coefficient, measuring the distribution of wealth, began to flatten.

THAT'S WHERE WE ARE TODAY. We clearly did not "escape" climate change or "solve" global warming—the temperature keeps climbing, though the rate of increase has lessened. It's turned into a wretched century, which is considerably better than a catastrophic one. We ended up with the most profound and most dangerous physical changes in human history. Our civilization surely teetered—and an enormous number of people paid an unfair and overwhelming price—but it did not fall.

We ended up with the most profound and most dangerous physical changes in human history

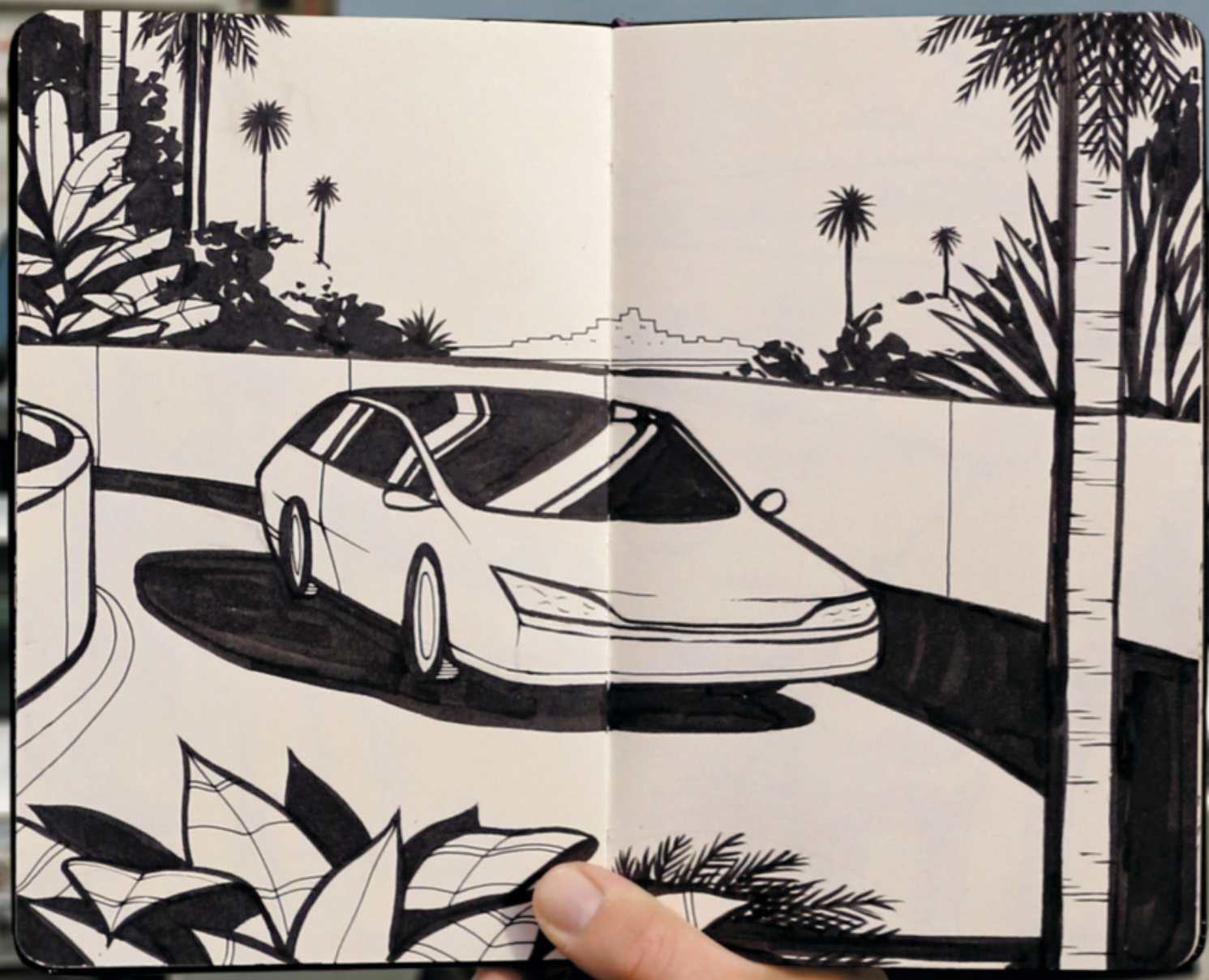
People have learned to defend what can be practically defended: expensive seawalls and pumps mean New York is still New York, though the Antarctic may yet have something to say on the subject. Other places we've learned to let go: much of the East Coast has moved in a few miles, to more defensible ground. Yes, that took trillions of dollars in real estate off the board—but the roads and the bridges would have cost trillions to defend, and even then the odds were bad.

Cities look different now—much more densely populated, as NIMBY defenses against new development gave way to an increasingly vibrant urbanism. Smart municipalities banned private cars from the center of town, opening up free public-transit systems and building civic fleets of self-driving cars that got rid of the space wasted on parking spots. But rural districts have changed too: the erratic weather put a premium on hands-on agricultural skills, which in turn provided opportunities for migrants arriving from ruined farmlands elsewhere. (Farming around solar panels has become a particular specialty.) America's rail network is not quite as good as it was in the early 20th century, but it gets closer each year, which is good news since low-carbon air travel proved hard to get off the ground.

What's changed most of all is the mood. The defiant notion that we would forever overcome nature has given way to pride of a different kind: increasingly we celebrate our ability to bend without breaking, to adapt as gracefully as possible to a natural world whose temper we've come to respect. When we look back to the start of the century we are, of course, angry that people did so little to slow the great heating: if we'd acknowledged climate change in earnest a decade or two earlier, we might have shaved a degree off the temperature, and a degree is measured in great pain and peril. But we also know it was hard for people to grasp what was happening: human history stretched back 10,000 years, and those millennia were physically stable, so it made emotional sense to assume that stability would stretch forward as well as past.

We know much better now: we know that we've knocked the planet off its foundations, and that our job, for the foreseeable centuries, is to absorb the bounces as she rolls. We're dancing as nimbly as we can, and so far we haven't crashed.

McKibben is the author of Falter: Has the Human Game Begun to Play Itself Out? *and a co-founder of 350.org*



AL GORE

Why I have hope for the climate-change battles to come

ONE OF THE IMPORTANT MILESTONES in the struggle to build awareness of the climate crisis in the U.S. was the publication 30 years ago by TIME of its historic "Planet of the Year" issue, focusing the nation's attention on our "Endangered Earth." Prior to its decision to creatively adapt its Person of the Year brand to help mobilize public opinion in response to the unprecedented threat to the future of humanity, TIME organized a 1988 conference of climate experts and policymakers to review the rapidly accumulating evidence confirming the warnings of scientists years earlier. All who attended felt it was the most impressive conference yet held to explore what many realized for the first time was an existential crisis.

In the late 1960s, I experienced my own unexpected awakening to this planetary danger as an undergraduate in a college class taught by the legendary scientist Roger Revelle, who was among the first scientists to discover that human activity was adding more carbon dioxide to the earth's atmosphere than nature could absorb. In 1965, Revelle had warned President Lyndon Johnson of the mounting crisis. Measurements made by Revelle's colleague Charles David Keeling from the top of Mauna Loa on the Big Island of Hawaii showed clearly that the increased burning of fossil fuels was leading to a dramatic rise in the concentrations of CO_2 measurements in the atmosphere.

Seven years after that class, as a young, newly elected member of the U.S. House of Representatives, I asked what was being done about this emerging threat and found the most common answer was, "What threat?"

During my first-ever congressional hearing on this crisis, I asked Dr. Revelle to be the leadoff witness, naively hoping when he spoke, those listening would have the same epiphany I had as an undergrad. When that didn't happen, I asked myself for the first time an urgent question that has preoccupied me ever since: How can this crisis be made as clear to our nation and to the world as Revelle made it to me?

Nearly 40 years later, although we have made a great deal of progress, we are not yet gaining on the crisis. It is still worsening faster than we are mobilizing to confront it. The evidence is now even more overwhelming, of course, and Mother Nature has joined the discussion. The U.N. Intergovernmental Panel on Climate Change recently issued its latest stark assessment, in which the world's leading scientists warned we must undergo an urgent and rapid transformation of our civilization in order to avert the most catastrophic effects of a disrupted global climate system.

We must be on guard against despair, which is ultimately just another form of denial when the future of humanity is at stake

Humanity is now spewing more than 110 million tons of global warming pollution every day into the exceedingly thin shell of atmosphere that surrounds our planet as if it were an open sewer. The extra heat energy being trapped on earth and exacerbated by man-made climate change is now equal to what would be released by 500,000 Hiroshima-class atomic bombs exploding on earth every single day, according to James Hansen, a leading climate scientist. And the knock-on consequences of all that extra heat energy is leading to increasingly dangerous threats to lives and livelihoods all around the world.

The past five years have been the hottest five years recorded since the world's top weather and climate agencies started tracking global temperatures in the 1880s. This past July was the hottest month ever in recorded history. More than 90% of the extra heat is going into the oceans, and it is fueling supercharged hurricanes. Hurricanes Harvey, Irma and Maria (all in 2017) caused as much as $265 billion in damages. Overall, weather disasters in 2017 and 2018 cost the global economy $653 billion—the costliest back-to-back years in history. Wildfires are worsening around the world, including across the American West, while farmers in the Midwest have dealt with periods of both catastrophic flooding and drought that destroyed crops and threatened the economic health of communities. Sea levels are rising at an accelerating rate as the melting of land-based ice in Greenland and Antarctica increases to record levels. The list goes on.

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

But we must be on guard against despair, which is ultimately just another form of denial when the future of humanity is at stake. Yes, some losses are not recoverable. And yes, more damage is now inevitable no matter what we do. False hope is also a form of denial, but I remain optimistic that we still retain the ability to avoid the most catastrophic consequences of this crisis and save the future of humanity—if we rise to the challenge and act urgently.

MY HOPE STEMS largely from the recent, unprecedented groundswell of youth activism that has raised public consciousness to new levels and is pushing political leaders to develop bold and ambitious ideas to confront this challenge. Harking back to the great social movements in history—women's suffrage, civil rights, gay and lesbian rights—youth activists are taking the lead. They are staging sit-ins at congressional offices, marching in the streets and protesting on college campuses. Above all, a growing number of students in many nations have been striking from school every Friday for more than a year to demand action on the climate crisis.

The movement has been led by a 16-year-old Swedish student named Greta Thunberg, who captured the world's attention with a groundbreaking speech at the U.N.'s annual gathering of world leaders in Poland last year. Thunberg speaks with startling clarity about the threat her generation faces and how political leaders have failed the test of leadership. Her words and advocacy embody the moral authority of youth activists who will bear the burden of the decisions previous generations make today.

Youth activists have also been at the ground level of the Green New Deal resolution put forward by 29-year-old Representative Alexandria Ocasio-Cortez of New York and longtime champion for climate action Senator Ed Markey of Massachusetts. Many of the ideas included in the Green New Deal have been around for years, but they have never been packaged together with momentum rooted in the energy and fervor of a new generation of leaders. The Green New Deal has indisputably played a critical role in pushing the Democratic Party's 2020 presidential candidates to propose concrete solutions to the issue at a scale that would have been unthinkable even just a few years ago.

The recent surge in youth activism, combined with the recent extreme weather related to the climate crisis, have underpinned a marked shift in public demand for action. According to the AP/NORC Center for Public Affairs Research, 71% of Americans agree climate change is happening. And among youth, there has been a striking change among Republicans: A 2018 Pew Research poll shows millennial Republicans are more likely to endorse centrist environmental positions.

One of the lessons of my years as a young member of Congress was that although change can sometimes come from the top, most often the biggest changes start at the grassroots level. Political leaders will pay attention if the calls to action are loud and persistent. Saving the future of humanity is a heavy burden for teenagers and 20-somethings to bear. But they are embracing the challenge as if their lives depend on it. The rest of us must follow their lead and act before it's too late.

Gore served as the 45th Vice President of the U.S.

2050: THE FIGHT FOR EARTH

ASIA

THE *Hottest* CITY ON EARTH

For a glimpse of our overheated future, pay a visit to Jacobabad, Pakistan

By Aryn Baker

Difference in Asia's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼ **0.47°**
1920s	▼ **0.26°**
1930s	▼ **0.18°**
1940s	▼ **0.02°**
1950s	▼ **0.18°**
1960s	▼ **0.06°**
1970s	▲ **0.07°**
1980s	▲ **0.34°**
1990s	▲ **0.69°**
2000s	▲ **1.14°**
2010s	▲ **1.29°**

SOURCE: U.S. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Photographs by Matthieu Paley for TIME

Ice sellers offer one of the few ways to stay cool in a city where electricity blackouts can last as long as 12 hours

IT'S JUST AFTER 7 IN THE MORNING IN THE Pakistani city of Jacobabad, and donkey-cart driver Ahsan Khosoo is already drenched in sweat. For the past two hours, the 24-year-old laborer has been hauling jugs of drinking water to local residences. When the water invariably spills from the blue jerricans, it hits the pavement with an audible hiss and turns to steam. It's hot, he agrees, but that's not an excuse to stop. The heat will only increase as the day wears on, and what choice does he have? "Even if it were so hot as if the land were on fire, we would keep working." He pauses to douse his head with a bucket of water.

Jacobabad may well be the hottest city in Pakistan, in Asia and possibly in the world. Khosoo shakes his head in resignation. "Climate change. It's the problem of our area. Gradually the temperatures are rising, and next year it will increase even more."

The week before I arrived in Jacobabad, the city had reached a scorching 51.1°C (124°F). Similar temperatures in Sahiwal, in a neighboring province, combined with a power outage, had killed eight babies in a hospital ICU when the air-conditioning cut out. Summer in Sindh province is no joke. People die.

To avoid the heat, tractor drivers in this largely agricultural area till the fields at night and farmers take breaks from noon to 3, but if life stopped every time the temperature surpassed 40°C (104°F), nothing would ever get done. "Even when it's 52°C to 53°C, we work," says Mai Latifan Khatoom, a young woman working in a nearby field. The straw has to be gathered, the seeds winnowed, the fields burned, the soil turned, and there are only so many hours in the day. She has passed out a few times from the heat, and often gets dizzy, but "if we miss one day, the work doesn't get done and we don't get paid."

If the planet continues warming at an accelerated rate, it won't be just the people of Jacobabad who live through 50°C summers. Everyone will. Heat waves blistered countries across the northern hemisphere this summer. In July, all-time heat records were topped in Germany, Belgium, France and the Netherlands. Wildfires raged in the Arctic, and Greenland's ice sheet melted at a record rate. Globally, July was the hottest month ever recorded.

Climate scientists caution that no spike in weather activity can be directly attributable to climate change. Instead, they say, we should be looking at patterns over time. But globally, 18 of the 19 warmest years on record have occurred since 2001. I asked Camilo Mora, a climate scientist at the University of Hawaii at Manoa who in 2017 published an alarming study about the link between climate change and increased incidences of deadly heat waves, if this was the new normal for Europe. He laughed. The new normal, he says, is likely to be far worse. It's likely to look something like Jacobabad.

Scientists estimate the probable increase in global average temperature will be at least 3°C by the end of the 21st century. That, Mora says, would mean three times as many hurricanes, wildfires and heat waves. People won't be able to work outside in some places, and there will be increased cases of heatstroke, heat-related illness and related death. In the U.S., extreme heat already causes more deaths than any other severe weather event, killing an estimated 1,500 people each year. A 2003 heat wave in Europe is estimated to have caused up to 70,000 deaths. Yet we still don't think of heat as a natural disaster on a par with, say, an earthquake, or even akin to a terrorist attack, says Mora. "Heat kills more people than many of these disasters combined. Europe [in 2003] was like a 9/11 every day for three weeks. How much more disaster do you want before we start taking it seriously?"

› *Khan Lala's repair shop stays busy all summer; few air-conditioning units can handle the extreme heat*

"IF YOU WANT to report on heat, this is the right place to be," Anees, a security guard working for my hosts in Jacobabad, cheerfully informs me as I arrive on a scalding June afternoon. Pakistan holds the heat record for Asia, he says proudly, though he has heard that it gets hotter elsewhere. It does, but the world's highest recorded temperatures—in California's Death Valley, for example—usually occur far from human habitation. Urban enclaves, where dense construction, a lack of green space and traffic congestion combine to create a heat-island effect, are rapidly catching up.

While Pakistanis regularly claim Jacobabad as the hottest city in the world, it depends on how you measure it. Various atmospheric-science organizations use different metrics, and record-breaking highs have ping-ponged between Iran, Pakistan and Kuwait over the past couple of years. After extensive

Laborers at a rice warehouse rest during the hottest part of the day

Fans, frequent baths and closed curtains help keep back the heat. Without air-conditioning, life still goes on at a Jacobabad fitness center

research, the World Meteorological Organization announced earlier this year that Turbat, Pakistan, 900 km (560 miles) to the southwest, could claim the title with a temperature of 53.7°C (128.7°F) on May 28, 2017. Jacobabad may very well win the endurance round, though, regularly surpassing 50°C (122°F) in the summer months.

Most days, the Jacobabad district, population 1 million, suffers from power outages that can last as long as 12 hours. Even when there is electricity, few households can afford an air conditioner. Locals rely on traditional remedies, like *thadel,* a supposedly cooling tonic made from ground poppy seeds mixed with spices, rose-flavored syrup and iced water. They also dress right for the weather, the women wearing *shalwar kameez* suits made of cotton lawn, a light, airy fabric. The loose trousers billow out from the waist, the long-sleeved tunic protects the arms, and a scarf covers the head. The men wear something similar, though without the vibrant patterns.

Khosoo, the donkey-cart driver, soaks his clothes in water several times a day, while tractor driver Nabi Bux swears that the Sindhi pop tunes blaring from his open cab take his mind off the heat. Sixty-something Mohammad Ayub, who sports a red cap sprinkled with tiny winking mirrors in the traditional Sindhi style, recommends taking frequent rests under a tree. The only problem is that most of the trees in the area have been chopped down for firewood. "Sometimes, when it gets above 52°, I feel like my brain is rolling around in my head." It was never that hot when he was a child, he complains. "We had more trees then. Now the trees are gone."

The only real remedy, says a local doctor, Abdu Hamim Soomro, is to stay hydrated and get out of the heat. *Thadel* is pure superstition, he says. Still, he drinks it. "Maybe it's the opium from the poppy seeds," he jokes. "It makes us feel better, and everyone is addicted to it."

Not even the night air offers much respite. The digital thermometer I had been carrying around with me registered 41.1°C (106°F) at 10 p.m. Instead of mattresses, most people sleep on charpoys—low cots of woven leather that allow the air to circulate underneath the body. The solar panels that run fans during the day don't work at night. Khosoo is one of the lucky ones; at night he puts his donkey back to work, treading a circle that powers his ceiling fan. But someone has to stay awake to keep the donkey going, he says, so either way, nights are rarely restful in the summer months.

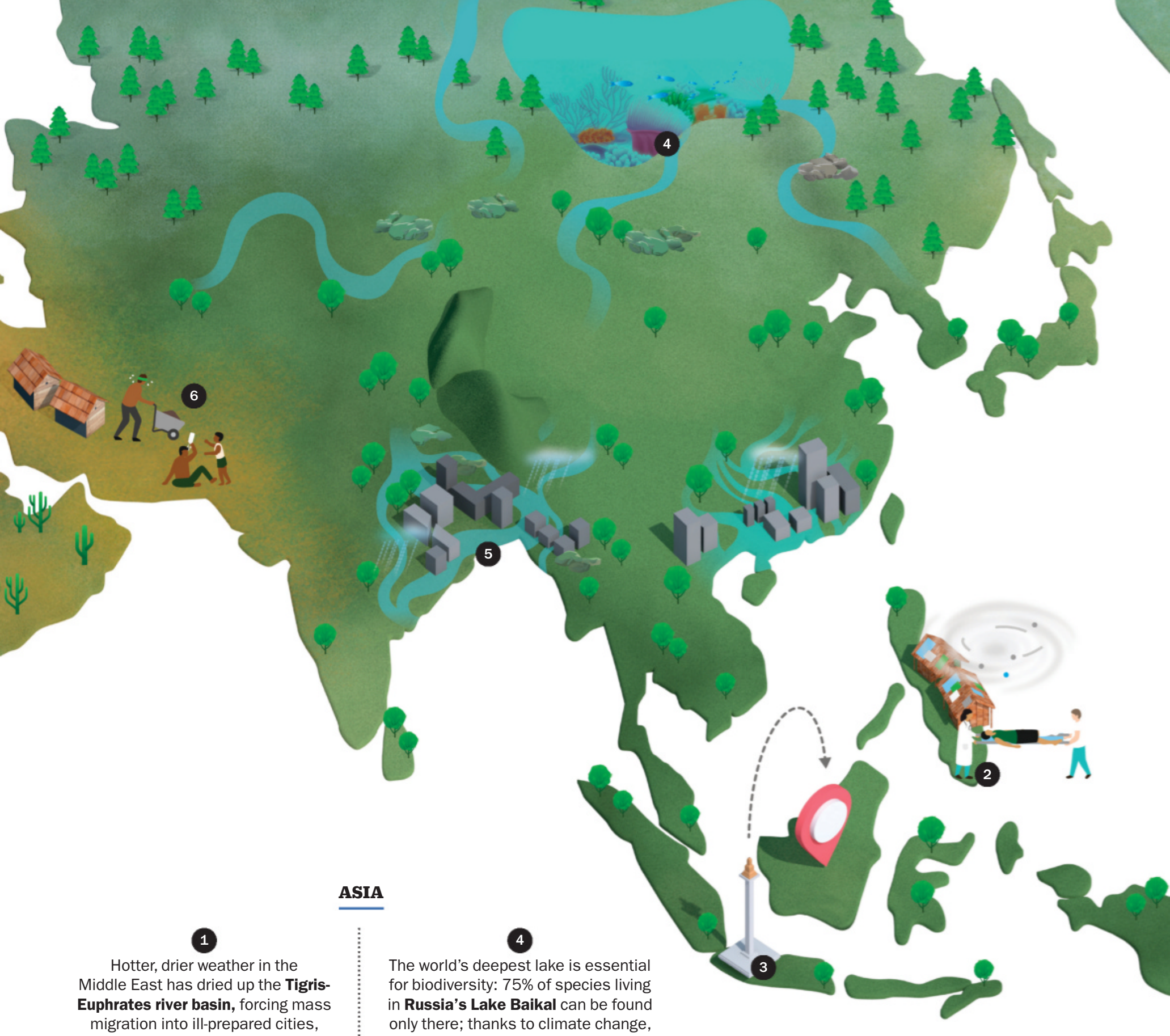
'People will have to find a way to adapt. But some will die, especially the weak and the elderly.'

Hamid Imam Soomro,
head physician at Jacobabad's Imam Medical Center

What seems like the minor inconvenience of a restless night has widespread ramifications, however. Nick Obradovich, a research scientist at the Massachusetts Institute of Technology Media Lab, started looking at the mental-health impact of climate change when colleagues noted a correlation between increased nighttime temperatures and suicide rates in the U.S. and Mexico. In tracking more than a billion social-media posts across multiple platforms from people living in varying climatic conditions, his team found that hotter-than-usual temperatures correlated with worse moods and an increase in reported mental-health difficulties. "If I were to say that climate change simply makes you grumpy, it doesn't sound all that catastrophic," Obradovich says. "But if grumpiness is one of myriad social changes that result, regularly, from unusually warm temperatures, we should be concerned about the cumulative effects of these changes over time on the long-term well-being of our society."

Humans are incredibly adaptive, but when it comes to heat, there is a limit. When the ambient air exceeds the normal body temperature of 37°C (98.6°F), the only way to keep from overheating is by evaporative cooling—a.k.a. sweating. But when the humidity is high, sweating is less effective because the air is already saturated with moisture. As a result, the body's core temperature increases, triggering a series of emergency protocols to protect vital functions.

First, blood flow to the skin increases, straining the heart. The brain tells the muscles to slow down, causing fatigue. Nerve cells misfire, leading



ASIA

1

Hotter, drier weather in the Middle East has dried up the **Tigris-Euphrates river basin,** forcing mass migration into ill-prepared cities, exacerbating regional instability

2

Five of the 10 deadliest typhoons on record to hit the **Philippines** have occurred in the past 15 years; the worst, Typhoon Haiyan, killed 6,300 people and displaced some 4 million

3

About 40% of the 10 million people in **Jakarta** live below sea level, thanks to rising oceans; Indonesia's President recently announced plans to move the country's capital to Borneo

4

The world's deepest lake is essential for biodiversity: 75% of species living in **Russia's Lake Baikal** can be found only there; thanks to climate change, these creatures are starting to die out

5

Sea-level rise has led to more intense storms and floods in the world's most populous river delta, **the Ganges;** similar problems face Vietnam's Mekong and China's Pearl River deltas

6

Jacobabad, Pakistan, used to see one or two weeks a year of 120°F-plus weather—now, say residents, it can be that hot for months on end; similar extreme heat plagues the region

to headache and nausea. If the core temperature continues to rise past 40°C to 41°C, organs start shutting down and cells deteriorate. Mora, at the University of Hawaii, described 27 different ways the body reacts to overheating, from kidney failure to blood poisoning when the gut lining disintegrates. All can result in death within a few hours.

Mora's team analyzed data on 783 lethal heat waves spanning 35 years, in order to quantify which weather conditions posed the greatest mortality risk. It turns out the old cliché that it's not the heat but the humidity holds true. Even relatively mild heat

MAP BY JING ZHANG FOR TIME

Police in Jacobabad serve punch to locals, to prevent heatstroke on the hottest days

Sunglasses, peddled
by a wandering salesman

waves with daytime temperatures of 38°C to 39°C (100.4°F to 102.2°F) turn deadly when humidity exceeds 50%. In Jacobabad, it rarely does, but by 2100, some 74% of the global population will experience at least 20 days per year when heat and humidity reach that deadly intersection, according to some studies. The U.S. National Oceanic and Atmospheric Administration estimates that increased heat and humidity has already reduced the amount of work people can do outdoors by 10% globally, a figure that will double by 2050."I don't think people quite grasp the seriousness of the situation," says Mora. "An entire set of livelihoods depends on being outside. Imagine being a construction worker who can't work for two months of the year."

In Pakistan, evidence of a climate crisis is easy to find. For the past few years, Pakistanis say, every summer has felt hotter, every drought longer, and every monsoon shorter and later in the season. "Before, it used to be one or two weeks of 50° days," says the nation's climate-change minister, Malik Amin Aslam. "Now it is months." These kinds of temperatures are not just deadly but also economically devastating. In a country surrounded by hostile neighbors, frequently targeted by terrorist groups and perpetually on the brink of nuclear war with India, Aslam ranks climate change as the "most severe existential threat facing Pakistan today." His office estimates that climate change could cost the country anywhere from $7 billion to $10 billion a year in disaster response alone, never mind lost economic activity. And Pakistan is no different than anywhere else, he warns. "With a temperature increase of three to five degrees that we are now looking at, the survival of the world is at stake. We cannot run away from it."

But to a certain extent, you can prepare for it. During the summer months, the Pakistani airwaves are full of public-service announcements warning residents about the dangers of heat, symptoms of heat exhaustion, and how to take precautions. Hospitals have dedicated wards for treating heat victims, and packets of oral rehydration salts can be found at any convenience-store cash register, next to the candy.

The only way to reduce heat waves would be to reduce global carbon emissions. But cities can make them safer by providing more green spaces. Anyone who has stepped under the shade of a tree on a hot day doesn't need science to prove that it's cooler, but according to the U.S. Environmental Protection Agency, the microclimate created by a few trees can reduce ambient temperatures by up to 5°C (9°F). Pakistani businessman turned environmentalist Shahzad Qureshi has taken that idea a step further by planting what he calls "urban forests" in the country's two largest cities, Lahore and Karachi. He says these microparks help a city breathe, and serve as natural recovery wards from the urban heat-island effect. Right now Qureshi's urban forests are privately funded, but he hopes they can become an example for smaller cities like Jacobabad, where government officials will see the benefit of growing urban forests over building yet another heat-trapping concrete behemoth.

› *Charpoys, traditional wood-and-leather cots, are a cooler alternative to modern mattresses*

IN THE MEANTIME, Jacobabad's Imam Medical Center sees up to 10 heat-exhaustion and heatstroke patients a day, a number head physician Hamid Imam Soomro expects to rise in the coming years. "People will have to find a way to adapt," he says. "But some will die, especially the weak and the elderly." He's particularly worried about children, who often have to walk long distances without shade to get to school.

Even healthy adults can suffer the effects. Halima Bhangar, a 38-year-old widow who lives in a small village not far from Jacobabad, lost her husband to heatstroke in May 2018. He had gone to town to sell some cattle when he started feeling dizziness and heart palpitations. He went to a pharmacy to pick up some rehydration salts, but it was too late. He collapsed in the street. "It was the heat that killed him," she says. "We were not aware of its repercussions."

We had crowded into Bhangar's one-room mud-brick house to escape the midday sun, and the heat was stifling. A solar panel propped up in the courtyard ran a ceiling fan that seemed to do little more than push the hot air around. I glanced down at the thermometer, which registered an outside temperature of 52.1°C, just a degree and a half shy of the country's record high. Bhangar followed my gaze. "How can we protect ourselves from this heat?" she asked. "For how much longer can we survive here?" She has considered moving, but where in the world is immune from the rising temperatures? "We can't run away from nature." □

GRAÇA MACHEL

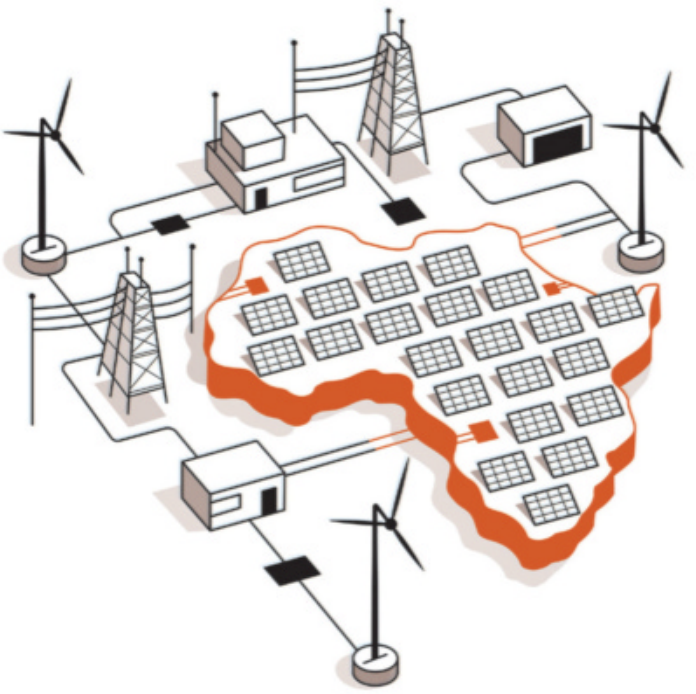
Africa can be the launchpad for a green-energy revolution

CLIMATE CHANGE is a global challenge that demands global solutions. But we must acknowledge the fact that the most underresourced parts of the world are bearing the brunt of climate change, despite bearing the least responsibility for rising emissions.

I have seen this with my own eyes in my native country of Mozambique. Earlier this year, Cyclones Idai and Kenneth wrought devastating havoc there and in neighboring Zimbabwe and Malawi. The city of Beira, one of the largest in Mozambique, was all but wiped from the face of the earth. Nationwide, more than 600 people were killed.

The impact will be felt for years to come. But the authorities don't just have to repair critical infrastructure. They also have to prepare for the future, potentially worse extreme weather as the effects of climate change worsen. And the political, migratory and economic disruption these effects set in motion will be felt far beyond Africa's frontiers.

If we are to limit global temperature increases, Africa needs to develop in a way that is truly sustainable. That means sources of energy that are clean and green—innovative renewables that will set a global example.



YET OVER HALF of people in sub-Saharan Africa today do not have access to electricity, often having to resort to using kerosene or cooking gas. Those who do have electricity often find it unreliable or costly, and sub-Saharan Africa's share of the global energy-access deficit more than doubled from 1990 to 2016. African entrepreneurs are driving growth, but inefficient electricity supply can hamper their efforts.

Investment in renewable energy is essential, and progress is being made: from 2014 to 2018, the World Bank provided more than $11.5 billion in financing for renewable energy and energy efficiency. In Mozambique, for example, a utility-scale solar power plant will help deliver power to rural areas. In Ghana, the World Bank is helping fund solar minigrids for about 10,000 people on islands in Lake Volta.

But international energy companies, donors and investors have a pressing responsibility to end financing of fossil-fuel projects in Africa. Powerful wealthy countries are still spending money so poorer ones can burn more fossil fuels. Japan's three biggest banks—Mizuho Financial Group, Mitsubishi UFJ Financial Group and Sumitomo Mitsui Financial Group—have been some of the biggest lenders to coal development across the globe, including in Africa. The U.K. has spent as much underwriting fossil-fuel projects overseas this decade as it has on international climate funding. If we are to limit global temperature increases to 1.5°C, we should not be investing in new fossil-fuel infrastructure.

Governments in Africa and in lower-income countries need to be more assertive in pushing for clean energy and action on climate change. They must refuse to be passive recipients of external aid regardless of strings attached. Political leaders need to listen to civil society and climate-change activists.

That's what happened in Kenya, where campaigners against what would be the country's first coal-fired power plant succeeded in getting an environmental license revoked, halting the project. I hope these and other activists inspire positive, radical action across Africa.

With vision, investment and determination, Africa can be the launchpad for a green-energy revolution that can inspire the world. The time to act is now. As Nelson Mandela said, "It always seems impossible until it's done."

Machel is a former Education Minister of Mozambique and a founding member of the Elders, a group of global leaders advocating for peace, justice and human rights

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

WHAT PAIN?

RELIEF THAT'S FAST. STRENGTH THAT LASTS.

Use as directed.

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The Women Who Will Save the World

From sinking islands to drought-ridden savannas, women bear an outsize burden of the global-warming crisis, largely because of gender inequalities. In many parts of the world, women hold traditional roles as the primary caregivers in families and communities, and, as the main providers of food and fuel, are more vulnerable when flooding and drought occur; the U.N. estimates **80% of those who have been displaced by climate change are women.** Given their position on the front line of the climate-change battle, women are uniquely situated to be agents of change—to help find ways to mitigate the causes of global warming and to adapt to its impacts on the ground. This reality was recognized by the Paris Agreement, which specifically included the global need to further empower women in climate decisionmaking. Today, across the world, from boardrooms and policy positions to local communities, from science to activism, women everywhere are using their voices to take leadership and call for action on climate change. **We've chosen 15 such women to highlight,** in profiles spread throughout the rest of this issue of TIME.

Christiana Figueres

DIPLOMACY

After heading a climate-change nonprofit for eight years, Christiana Figueres took on leadership of the UNFCCC, the body responsible for international climate-change negotiations, at the agency's lowest point. Just five months earlier, the world failed to reach an agreement at the 2009 Copenhagen summit. She injected a unique sense of optimism, attempting to remove the talks from what she calls "the political trash can." It worked: Figueres successfully steered world leaders to reach the Paris Agreement in 2015. Along with a number of other women involved in the negotiations, Figueres was successful in shedding an important light on the gender dimension of climate change. She's now writing a book about what the world needs to do in the next 10 years to combat climate change.

—Jennifer Duggan

Sunita Narain

ADVOCACY

An environmental-policy researcher since 1982, Sunita Narain has won awards for work on issues ranging from rainwater harvesting to tiger conservation to air-pollution mitigation. "The thing I feel good about is that we've always focused on the solutions," she says. Today, she's concerned that minority voices from the Global South are being drowned out in the climate-change dialogue. "[It] has to be a much more inclusive issue," she says. "Everybody has the right to development, which means everybody has the right to clean energy."

Narain believes Indian politicians and media are starting to take climate change more seriously now that floods and devastation have become a reality. Now they—and leaders from other developing countries—need to speak up at a global level to urgently reduce emissions, she says. "I have a lot of faith in humankind, and if you explain the immorality of the impact on the poor, they will understand. Our battle may not be completely lost."

—Naina Bajekal

'We don't have any other option but to do what science demands. We cannot do anything less because the consequences are so drastic.'

—Christiana Figueres,
former executive director of the U.N. Framework Convention on Climate Change

Ellen Page

COMMUNICATION

Late last year, actor and activist Ellen Page read two books—Joan Baxter's *The Mill: Fifty Years of Pulp and Protest* and Ingrid Waldron's *There's Something in the Water*—that opened her eyes to the environmental racism plaguing generations of indigenous and black communities in her home province of Nova Scotia, Canada. Page channeled her anger into a new documentary based on Waldron's work (and sharing its title), which examines the health impacts of environmental racism and the resistance efforts of affected communities. In the film, Page returns to Nova Scotia and talks to women leading the charge to restore their communities. They band together, for example, to prevent a company from building a natural-gas storage facility that would harm the Shubenacadie River, and to fight for the cleanup of Boat Harbour, a former aquatic hub for the Pictou Landing First Nation polluted by wastewater from a nearby pulp mill. "The level of cruelty in what I witnessed, in what these individuals have lived with, is disturbing and horrific," says Page. "These issues are life or death, literally." *—Mahita Gajanan*

Rhiana Gunn-Wright

POLICY

While working in Detroit's department of health in the mid-2010s, Rhiana Gunn-Wright realized how the environment shapes a wide range of social-justice issues. The government urgently needed to address climate change, she thought, but "you weren't going to solve the problem with just solar panels," she says. "People were being poisoned." Now, Gunn-Wright is bringing that holistic approach to the national level, working behind the scenes at New Consensus, a think tank with ties to progressive lawmakers. As the group's Green New Deal policy lead, she is charged with thinking through the nuts and bolts of the program and strategies to pitch the bold climate plan. If progressive Democrats make further gains in Washington, Gunn-Wright's proposals could wind up as law.

—Justin Worland

ILLUSTRATIONS BY JACQUI OAKLEY FOR TIME

2050: THE FIGHT FOR EARTH

AFRICA

Difference in Africa's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼	**0.32°**
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1940s	–	**0°**
1950s	▼	**0.15°**
1960s	▼	**0.06°**
1970s	–	**0°**
1980s	▲	**0.29°**
1990s	▲	**0.49°**
2000s	▲	**0.81°**
2010s	▲	**1.14°**

The Great *Green Wall* of Africa

An $8 billion planting project to combat the effects of climate change in the Sahel

By Aryn Baker/Mbar Toubab, Senegal

Members of a women's association pull weeds from seedlings that will eventually be replanted in Koyli Alpha, Senegal

PHOTOGRAPHS BY JANE HAHN FOR TIME

THE SEEDLINGS ARE READY. ONE HUNDRED and fifty thousand shoots of drought-resistant acacia, hardy baobab and Moringa spill out of their black plastic casings. The ground has been prepared with scores of kilometer-long furrows leading to a horizon studded with skeletal thorn trees. It's early August, and in less than a week, 399 volunteers from 27 countries will arrive in this remote corner of northern Senegal to participate in one of the world's most audacious efforts to combat the effects of climate change: an $8 billion plan to reforest 247 million acres of degraded land across the width of Africa, stretching from Dakar to Djibouti.

The Great Green Wall project, spearheaded by the African Union and funded by the World Bank, the European Union and the United Nations, was launched in 2007 to halt the expansion of the Sahara by planting a barrier of trees running 4,815 miles along its southern edge. Now, as concerns mount about the impact of climate change on the Sahel, the semiarid band of grassland south of the Sahara that is already one of the most impoverished regions on earth, the Great Green Wall is filling a new role. The goal now, say its designers, is to transform the lives of millions living on the front line of climate change by restoring agricultural land ruined by decades of overuse; when done, it should provide food, stem conflict and discourage migration. When the project is completed in 2030, the restored land is expected to absorb some 250 million metric tons of carbon dioxide from the atmosphere, the equivalent of keeping all of California's cars parked for 3½ years.

Over the course of a week, the volunteers descending upon the Senegalese village of Mbar Toubab will try to turn 494 acres of barren land into another forested brick in the Great Green Wall. There is only one problem: the annual rains have yet to arrive, and without them, none of the seedlings will take root. "The rain used to come in June. Here we are in August, and still there is no rain," says El Hadj Goudiaby, who has spent the past nine years overseeing Great Green Wall projects in Mbar Toubab for Senegal's forestry department. How is it possible, he asks, to grow trees to combat climate change if climate change is making it impossible to grow trees?

The answer may have more to do with changing attitudes than changing the landscape. When people think of potential fixes for global warming, they tend to focus on big projects. But if human activity is at the root of climate change, whether it be the carbon emissions of the industrialized world or the overgrazing of the Sahel, then that is where the solution lies as well. Environmentalists celebrate the Great Green Wall for its epic territorial ambition, but its biggest impact will come from allowing people to meet their needs without destroying nature in the process.

Land in Mbar Toubab, Senegal, that was plowed in anticipation of the planting of seedlings for the Great Green Wall

THE SAHARA ISN'T EXPANDING so much as the Sahel is shrinking, destroyed by decades of overgrazing, climate-change-induced drought and poor farming practices that have stripped the once lush grasslands of the fertile topsoil needed to regenerate. Cattle herders resort to the few remaining trees for animal fodder, denuding the landscape even further in a downward spiral of desertification. Planting trees not only reduces carbon on a global scale—research in the journal *Science* estimates planting more than 2 billion acres of trees could remove two-thirds of all the emissions that human activity has pumped into the atmosphere since the Industrial Revolution—it also recharges the water table and creates microclimates that increase local rainfall. *(For more on rewilding and carbon reduction, see story on page 52.)* But if pastoralists have nothing to feed their herds in the time it takes those trees to mature, they are likely to use the saplings, starting the cycle all over again. Which is why, though it may not sound like much, the solution to climate change in the Sahel starts with getting grass to grow.

"If we can solve people's problems by improving their living conditions now," says Goudiaby, "they will be able to help themselves by protecting the trees that protect their future." After all, stopping global warming isn't about saving the

AFRICA

1

The **Indian Ocean coastline** will see more disasters like 2019's Cyclone Idai, which killed 1,297 people and caused $2 billion in damages

2

The snows of **Mount Kilimanjaro** have already all but disappeared; glacial melt is likely to see the continent's glaciers disappear in the next decade

3

In the **Sahel,** droughts have led to deadly fighting over resources in arid regions south of the Sahara

4

Estimates suggest rising ocean temperatures will lead to a 53% drop in the fisheries of **Nigeria,** 56% in **Ivory Coast** and 60% in **Ghana**

5

The Horn of Africa is facing the worst food crisis in the 21st century, affecting some 12 million people in Ethiopia, Kenya and Somalia

6

Rising sea levels have led to the flooding of **coastal villages in West African countries,** driving inhabitants to migrate to urban areas or abroad

MAP BY JING ZHANG FOR TIME; ILLUSTRATION BY JACQUI OAKLEY FOR TIME

planet; the earth will survive no matter how much the climate changes. It's about saving humanity. One way to do that is by helping those who are most vulnerable to what chaos we have already created.

Just 25 miles south of Mbar Toubab, near the village of Koyli Alpha, 50-year-old Dienaba Aka pulls her heavily laden donkey cart to the side of the road. She and her extended family have spent the day cutting grass in a "forage bank" managed by the national Great Green Wall agency. For the past eight months, the 1,700-acre field has been fenced off to let the grass, along with 250,000 saplings, grow undisturbed by the cattle, sheep and goats that roam free in this region. The field reopened in July, and now herders pay $1.70 a day to harvest the waist-high grass for their cattle until the rains bring new grazing opportunities. For Aka, the idea of a grass "bank" is a radical departure from an itinerant childhood spent following the family herd in search of forage. Now she can feed her cattle in the lean season without stripping trees.

Aka, like women from many villages in the region, has been planting trees for the GGW project since 2012. She earns $96 during the six-week planting season. It's good money, she says, but most women do it because they have been told it will bring back the rain, which in turn brings the grass that feeds their livestock.

There is another advantage to forage banking, Aka says, gazing proudly

CLIMATE OPTIMISTS

Rachel Kyte

SUSTAINABILITY

As climate change has exploded as an issue on the international scene, Rachel Kyte has become a go-to expert for heads of state and multinational CEOs trying to figure out how to transition away from fossil fuels. In the lead-up to the September 2019 U.N. Climate Change Summit, she has played an influential role leading the U.N. Secretary-General's push for countries and companies to make new commitments to expedite the energy transition. As the leader of the World Bank's climate program ahead of negotiations that yielded the Paris Agreement, Kyte developed strategies to make hundreds of billions of dollars available to developing countries eager to address climate change but lacking the resources. Kyte, just named dean of the Fletcher School at Tufts University, currently leads a nonprofit, Sustainable Energy for All, that seeks to bring energy to under-developed places while also helping them move away from fossil fuels. "We have to make sure we take care of everybody," she says.

—Justin Worland

CLIMATE OPTIMISTS

Greta Thunberg

YOUTH ACTIVISM

In 2018, then 15-year-old Greta Thunberg started a school strike in Sweden to draw attention to the climate crisis, and since then her message has spread—despite her avoidance of air travel because of its high carbon emissions. Young people across the world have followed her path, striking and marching to make clear to adults and decisionmakers that this is a true emergency. "We are children saying, 'Why should we care about our future when no one else is doing that? And why should we bother to learn facts when facts don't matter in this society?' When children say something like that, I think adults feel very bad," Thunberg told TIME in April. In late August, she landed in the U.S. after a 15-day boat trip across the Atlantic, and she has plans for a months-long tour of the Americas—with a zero-carbon footprint. "This is an existential crisis that is going to affect our whole civilization, the biggest crisis humanity has ever faced," she says. "I'm not planning to stop this movement, and I don't think anyone else is either."

—Suyin Haynes

From left: weeding seedlings in Koyli Alpha; project manager El Hadj Goudiaby tends to a lemon tree in Mbar Toubab

at her two 10-year-old nieces perched atop several bags of recently cut grass. "Before the Great Green Wall, the kids had to go with us when we took the cattle to graze. Now they can stay in school." In Mbar Toubab, the fees collected from last year's forage bank paid for solar panels to power classrooms. This year they will cover construction of a dormitory for students who live too far to walk every day. The circular investment is part of the plan, says Goudiaby. "If we can make the children aware of the consequences of our actions today, they will teach the next generation."

THE SEEDLINGS in Senegal's reforesting projects are usually locally sourced and selected for their drought resistance and hardiness. Thorny desert acacias carry their own protection from grazing animals, and in the dry season they shed their leaves to conserve moisture. Once baobabs take root, they are long-lived even under drought conditions. Their bark can be used to make rope, their leaves are edible, and their foot-long fruit can either be juiced or ground up and roasted to make a coffee-like drink.

Fruit trees are often overlooked in reforestation schemes that prioritize hardiness, and that needs to change, says Ali Haider, the incoming director of Senegal's Great Green Wall agency. "If you give someone a tree that she doesn't need, she won't take care of it." Give her something she values instead, he says, something she can cook, sell or use for medicine. "Then she will protect it because it improves her life."

Some of Senegal's GGW agency projects do just that on a grand scale, like investing in gum arabic plantations for export. Since Senegal's first sapling in the Great Green Wall took root in 2008, the national agency says it has planted 18 million trees on 99,000 acres of restored land. Nine market gardens are up and running, and three times as many forage banks are keeping cattle fed in the lean season. Gazelles, jackals, desert tortoises and songbirds—not seen in the region for years—are returning.

All of that amounts to very little compared with the scale of the overall problem, says Chris Reij, a senior fellow at the World Resources Institute who has been working on desertification in the Sahel since 1978. Even if 99,000 acres have been reforested in Senegal, a figure he thinks is likely inflated, the acreage of forested land disappearing because of logging, agriculture and construction in other parts of the country is many times higher, he says. "So unless you do something about that, you are still losing the battle." Nor does he think massive

plantations are the solution. The survival rate of planted trees in arid regions like the Sahel hovers around 20%. "If all the trees that have been planted in the Sahel since 1980 had survived, it would look like the Amazon by now," he says.

Goudiaby concedes that planting trees on the edge of the Sahara may not be the most cost-effective solution to climate change. But given time, he says, it works. Over the nine years he has been working the plots of Mbar Toubab, he estimates a 70% survival rate. A walk through one of the earliest plantations in the area does show signs of progress. Some of the trees are 10 ft. to 12 ft. tall, and though it's not exactly a forest, it's certainly not barren land either.

Reij argues it would be more cost-effective to restore the original grasslands, which are almost as good at capturing carbon. Mali, Burkina Faso and Niger, for example, are fencing off large areas to allow the land to recover from the effects of overgrazing over time. In agricultural areas, farmers are being taught to plant around existing trees and sprouts, rather than plowing them over. The result, says Reij, "has been mind-blowing," with 12 million acres regreened in Niger over the past 30 years.

No one approach is better than the other, says Ibrahim Thiaw, the executive secretary of the U.N. Convention to Combat Desertification. Whether countries plant trees or promote grasslands, the end result is 21 African nations are working together to combat climate change and make people's lives better in the Sahel. His biggest concern is that so far, only 15% of the proposed area has been restored. Some of the delays are because of a lack of funding. Senegal spends $200 million a year on planting and caring for its section of the wall; poorer nations of the alliance can't afford even that. Only half the $8 billion pledged for the project has come through, largely because other climate emergencies are drawing attention away from the Sahel.

Long-term, says Thiaw, the impact of climate change on one of the world's most impoverished regions will have global repercussions. Some 150 million people live in the Sahel, nearly two-thirds under age 25, and the region has the highest birth rate in the world. The World Bank predicts climate change will force about 85 million sub-Saharan Africans to migrate, many to under-resourced urban enclaves in the region, while a significant number will attempt the deadly passage to Europe and the Gulf countries in search of opportunity. "It's a time bomb," says Thiaw.

The immediate risks are equally troubling. Across the region, governments have lost local control to extremist groups such as Boko Haram, al-Qaeda and the Islamic State. Some 4.2 million people have been displaced by drought and conflict, particularly in the region bordering Lake Chad, which used to supply fresh water and livelihoods to nearly 30 million people but has shrunk by 90% because of climate change and overuse. The lack of economic prospects provides rich recruiting prospects for Boko Haram, which can dangle employment and goods that are otherwise unavailable. Dennis Garrity, the Drylands ambassador to the U.N. Convention to Combat Desertification, likens conditions in the Sahel to those in the impoverished, ungoverned swaths of Pakistan and Afghanistan that were the font of global terrorism two decades ago. "The Sahel is not only the area most vulnerable to climate change in the world, it is also the region where terrorism and extremism are growing most rapidly," he says.

The rains finally came to Mbar Toubab on Aug. 19, a full month later than the year before. There wasn't much, but it was enough for the volunteers to get started, and by the time they left, 88,000 seedlings had been carefully set into the ground. The irony of people flying in from as far away as Hong Kong to plant trees to combat climate change, which is exacerbated in part by transcontinental flights, is not lost on Goudiaby. "Maybe they are making up for climate sins they have committed back in their home countries," he proposes, a kind of climatic reparation. The countries of the Sahel contribute least to global warming, yet they reap the worst repercussions of the wealth generated by more industrialized nations. It only seems fair, he says, that members of those nations come to Senegal to pay their debts. □

353 million
Number of trees planted in Ethiopia in 12 hours on July 29, a world record

47%
Projected increase in the population of the Sahel by 2050, to 340 million people total

85 million
Number of people in sub-Saharan Africa projected to migrate because of climate change

ILLUSTRATION BY JACQUI OAKLEY FOR TIME

JANE GOODALL

The devastation of climate change is real. But there are reasons to be hopeful

I'VE STOOD with Inuit elders by a great ice cliff in Greenland as water cascaded down and icebergs calved. It never used to melt, the elders told me. I've witnessed the shrinking of a Mount Kilimanjaro glacier. I've watched wildfires rage in Africa and in California. And I've seen the carcasses of animals who have died in droughts.

As I travel around the globe, people tell me how the weather patterns have been disrupted and the worst kind of hurricanes, typhoons and cyclones are getting more destructive and more frequent. It is because we are polluting and destroying the environment by using natural resources in an unsustainable way.

When I started my research in Gombe, Tanzania, in 1960, it was part of the forest belt that stretched across Africa. In 1990, I looked down from a small plane on an island of forest surrounded by completely bare hills. More people were living there than the land could support, so trees had been cleared to grow food or make charcoal.

In order to slow down climate change, we must solve four seemingly unsolvable problems. We must eliminate poverty. We must change the unsustainable lifestyles of so many of us. We must abolish corruption. And we must think about our growing human population. There are 7.7 billion of us today, and by 2050, the UN predicts there will be 9.7 billion. It is no wonder people have despaired. But I believe we have a window of time to have an impact. Here's why I'm still optimistic.

THE RESILIENCE OF NATURE

Habitats and species on the brink of extinction can recover if given a chance. When I realized the plight of the people living around Gombe, the Jane Goodall Institute started a program called Tacare to help them find ways to make a livelihood that did not involve devastating the environment. As they realized that protecting forests is good not only for wildlife but also for their own future, they became our partners in conservation. Today we have Tacare in six other African countries, and the hills in Gombe aren't bare anymore.

THE HUMAN BRAIN

How is it possible that the most intellectual creature ever to walk the earth is destroying its only home? There has been a disconnect between our clever brains and our hearts. We do not ask how our decisions will help future generations, but how they will help us now, how they will help our shareholders, etc. Yet every day we are also inventing technology that enables us to live in greater harmony with the natural world (clean energy, for example). Those same communities around Gombe are using smartphones and satellite imagery to monitor their forests and set aside village land for regeneration.

SOCIAL MEDIA

These networks have enabled us to connect on issues in a way never before possible. It was the People's Climate March in New York in 2014 that showed me this in real time. People posted and told others to join them, and what was supposed to be a march of 100,000 turned into one of 400,000.

THE POWER OF YOUNG PEOPLE

I started Roots & Shoots—a program in which kindergartners and university students alike choose projects to make the world a better place for animals, people and the environment—in 1991 when I realized how many had lost hope. It exists now in more than 50 countries, and many participants are working on climate-change-related issues.

If we all get together, we can truly make a difference, but we must act now. The window of time is closing.

Goodall, founder of the Jane Goodall Institute and a U.N. Messenger of Peace, is an ethologist and conservationist

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

MORAL INJURY IS A WAR INSIDE

No one should fight alone

Imagine a nurse who blames herself for losing a patient. She questions her own self-worth and abuses painkillers to numb the constant emotional stress. She's one of the many who struggle with Moral Injury. At Volunteers of America, we can help her find peace.

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2050: THE FIGHT FOR EARTH

EUROPE

Difference in Europe's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼	0.33°
1920s	▼	0.23°
1930s	▲	0.14°
1940s	▼	0.15°
1950s	▼	0.02°
1960s	▼	0.04°
1970s	▼	0.03°
1980s	▲	0.02°
1990s	▲	0.52°
2000s	▲	1.05°
2010s	▲	1.35° ←

Take a Walk on the Rewilding Side

Fifty miles east of London, a stretch of reclaimed land holds a key to our future

By Ciara Nugent/Wallasea Island, U.K.

A project to build a network of salt marshes, grasslands and lagoons on Wallasea Island on England's eastern coast is due for completion in October

AVOCETS, TERNS AND GULLS SWOOP DOWN ONTO WALLASEA Island on England's eastern coast, searching for food between blades of grass ruffled by the summer sea breeze. Aside from the wind, and the odd chirp or squawk, it's quiet—the kind of peaceful scene that seems like it's been going on for centuries. Yet five years ago, these wetlands didn't exist.

The mud the birds have landed on once lay under the streets of central London. In 2015, as part of a railway project, a construction crew scooped more than 3 million metric tons of dirt out from beneath the capital, drove it 50 miles east and piled it onto farmland on the coastline of the county of Essex. In summer 2019, a crane hoisted old heavy machinery out of the water, removing the last vestiges of human interference.

Wallasea is the largest restored coastal wetland in Europe, an exemplar of a growing movement to "rewild" land and return it to the way it was before humans began exploiting it millennia ago. It's good for the birds. But it's also increasingly understood as crucial for ensuring a world hospitable to people. As water sloshes in and out of Wallasea's restored mudflats and salt marshes, carbon dioxide that could otherwise

PETER MACDIARMID—GETTY IMAGES; ILLUSTRATION BY JACQUI OAKLEY FOR TIME

escape into the atmosphere and contribute to global warming gets buried. "Bits of decomposing leaves and seaweed come down rivers to the coast," explains Rob Field, a senior conservation scientist at the Royal Society for the Protection of Birds, which runs Wallasea. "When it gets to the [slow-flowing] salt marshes, the carbon falls out of suspension and gets stored there, in the thick, gloopy mud." Ecologists say coastal wetlands like these are capable of trapping carbon up to 40 times faster per hectare than tropical rain forest. But over the past 400 years, farmland, coastal development and rising sea levels have combined to destroy 91% of wetland habitats on the Essex coast. Worldwide, 35% of global wetlands were destroyed from 1975 to 2015, according to the U.N.

Scientists say it's too late to prevent catastrophic climate change by only reducing greenhouse-gas emissions. As well as rapidly phasing out fossil fuels, the world also needs to deploy so-called negative-emissions technologies to draw down large amounts of the carbon dioxide already in the atmosphere. Many believe that nature restoration is the cheapest and simplest way to do it. Other options, including machines that catch carbon as it is being emitted by power plants or suck carbon out of the atmosphere to store it underground, need research, money and time to mature before they can be used on a large scale. For that reason, most Intergovernmental Panel on Climate Change pathways for limiting warming to 1.5°C above preindustrial levels rely on forestry and better land management to make up the bulk of carbon drawdown over the next 30 years. To save the planet, we may need to give some of it back to nature.

IN EUROPE, home to some of the most densely populated land in the world, and where true wilderness has become almost nonexistent, the idea of bringing nature back while also fighting climate change has captured the imagination. Dozens of privately and publicly funded rewilding projects have popped up across the continent. Europeans are reviving coastal habitats like Wallasea in the U.K., reversing the drainage of peatland bogs in Germany and replanting forests in the Scottish Highlands. The projects not only sequester carbon but also boost biodiversity and help the land adapt to the changing climate by preventing floods and wildfires.

Advocates of nature restoration say those benefits give rewilding an edge over simple tree planting, which has been popular with European governments for decades. From 2005 to 2015, Europe's forest cover grew by the equivalent of 1,900 football fields every day, as the E.U. spent several billion euros to fund tree planting, often on farmland that had been abandoned because of changing agricultural practices in places like France and Italy. Some of that was reforestation, using native species to restore forests to what they were before, but much of it was

CLIMATE OPTIMISTS

Miranda Wang

INVENTION

Ten years ago, Miranda Wang went on a school field trip to a waste-management facility and was shocked by the vast amount of plastic she saw there, destined for landfill. Now 25, Wang is CEO and co-founder of a Silicon Valley–based startup, BioCellection, that transforms the most commonly used and unrecyclable plastics into new materials using pioneering chemical technology. "[Plastics] are just natural compounds and natural carbons tied together in an unnatural way, and once you disrupt that, you can use those natural building blocks to make anything," says Wang. "We can make a product from plastic garbage that's not only useful in new products, but it is biodegradable and can break down." The company's pilot program with San Jose, Calif.'s waste-management facility has already received accolades from groups like the U.N. Environment Programme, and now Wang is setting her sights on other cities all over the world.

—Suyin Haynes

Negative-emissions plants like this one by Swiss firm Climeworks filter CO_2 directly out of the air

LUCA LOCATELLI—INSTITUTE; MAP BY JING ZHANG FOR TIME; ILLUSTRATION BY JACQUI OAKLEY FOR TIME

so-called afforestation, the planting of many of one species of tree where there was none before, in regular lines. Many afforested trees are regularly cut down and used to produce timber, paper or biofuel.

Rewilding advocates say afforestation, while offering similar carbon-sequestration capacity to reforestation, offers little benefit to wildlife and carries risks. Studies have found that the large-scale planting of nonnative trees in Canada and China have disturbed natural ecosystems, worsened wildfires and depleted groundwater levels.

Meanwhile, other landscapes have been neglected. "I think politicians like planting trees because it's a very clear, simple action," says Timon Rutten, head of enterprise at Rewilding Europe, a Netherlands-based NGO that oversees nature-restoration schemes from Portugal to Bulgaria. "But peatlands, wetlands and grasslands are just as good or sometimes even better at storing carbon."

Northern European countries shelter large expanses of peatlands—sometimes called moors, bogs or mires—that perhaps offer the greatest opportunity for natural climate mitigation. The plants that grow on the surface of peatlands sequester, or absorb, carbon dioxide as they grow. When they die, the decomposing plants do not leach carbon back into the atmosphere but get buried in waterlogged bogs, compressing into a new layer of peat. These habitats cover about 3% of the globe but contain more stored carbon than all other kinds of vegetation on earth combined. They sequester 370 million metric tons of CO_2 per year. But 15% of the world's peatlands have been drained for agricultural use, or so that their peat could be burned to power generators, emitting carbon dioxide in the process. The dried-out peatland that's left behind then releases stored carbon into the atmosphere; peatlands now account for almost 6% of annual global human-caused carbon emissions. E.U.-funded rewilding projects in Finland, the U.K. and Germany are rewetting peatlands to turn them back into carbon sinks.

Rewilding advocates are competing for investment with more modern negative-emissions technologies. Dozens of companies are developing carbon capture and storage (CCS) technology, in which machines use chemical processes to filter CO_2 out of the air. The gas is then used to make products or stored underground, removing it from the atmosphere.

Swiss startup Climeworks, for example, scrubs CO_2 from the air at plants in Italy, Switzerland and Iceland, at a cost of $500 to $600 per metric ton of CO_2. It is then sold for use in greenhouses, soda manufacturing and biofuel production, or stored in rocks deep underground.

But most IPCC plans for preventing more than 1.5°C of warming include a different kind of CCS: bioenergy and carbon capture and storage (BECCS), which should account for the majority of negative emissions by the end of the century. BECCS power stations burn trees and plants—which have sequestered carbon while growing—to produce electricity, then trap the resulting CO_2 emissions. The U.K. government has invested $32 million in domestic BECCS projects, including the first pilot program to launch in the E.U., the Drax power station in the U.K., which went online in February.

Currently, these high-tech methods for removing carbon from the atmosphere are expensive and so have limited reach. Rewilding, at least at the moment, is cheaper and more proven. Peatland restoration, for example, can trap a metric ton of CO_2 per year for about $16.

Despite the low cost, however, there are obstacles to rewilding on a meaningful scale. "There's a limited amount of land that we can do restoration on," says Simon Lewis, a professor of global change science at University College London. The mudflats and salt marshes at Wallasea currently bury around 1,200 metric tons of CO_2 a year—the equivalent of the per capita emissions of only around 200 Brits in 2018. The U.K. would need to rewild wetlands about 10 times the size of the entire country's land area to zero out national carbon emissions.

Large-scale nature restoration also doesn't yet have real political support.

The British government's current rewilding plans include just 500,000 hectares of land—0.2% of the country's total surface area—over the next 25 years. And privately funded rewilding schemes often come up against resistance; one of the largest such projects, Summit to Sea, which calls for the restoration of ecosystems on 10,000 hectares of farmland in Wales, has attracted fierce opposition from local communities and agricultural groups, which fear no longer being able to use the land for their livelihoods.

AT WALLASEA, the illusion of unspoiled nature was punctured on the July morning TIME visited by a plume of dark gray smoke above the island's north edge. The British military uses nearby land to dispose of expired ammunition, explains site manager Rachel Fancy. "We get a lot of big bangs out here."

Nevertheless, Fancy says she expects humans will find more ways to coexist with nature in the coming decades, especially as climate change threatens both. Rewilding doesn't just sequester carbon—it also reduces the risk of floods and wildfires, both of which are becoming more frequent on a warming planet. Over the next 100 years, Wallasea's salt marshes should creep up the sand dunes and act as a natural flood defense, protecting nearby homes and farmland even as man-made walls are overwhelmed by rising sea levels and increased storm surges.

Wallasea is doing its bit to stave off the worst of that climate breakdown, as it buries carbon amid samphire and sea lavender. Meanwhile, the birds can relax here. The weather is fine, for now. □

EUROPE

1 A heat wave in **Western Europe** in 2019 set new temperature records in Germany, France, Belgium and other countries

2 **Bordeaux, France,** is one of many economically important wine-growing areas threatened by worsening droughts

3 Rising temperatures are causing permafrost in **western Siberia** to melt and increasing the risk of fires in boreal forests

4 In the **North Sea,** global warming is affecting plankton and the marine food chain, compounding the pressures of overfishing

5 Summer droughts threaten some of Europe's most important commercial waterways, like the **Rhine River,** which dried up so much in 2018 that shipping was partly shut down

6 **Lithuania**'s specific geography makes it the European country most vulnerable to climate change; it's already seen three straight years of devastating crop failures

CLIMATE OPTIMISTS

Tessa Khan

LAW

In 2015, Tessa Khan was living in northern Thailand and working on behalf of a women's human-rights nonprofit when news of a district-court case more than 5,000 miles away caught her attention. A court in the Hague had ruled in favor of some 900 Dutch citizens and a group known as the Urgenda Foundation, which had sued the Netherlands, demanding that the state reduce its greenhouse-gas emissions. Khan realized the courts could be a powerful tool to fight climate change and in the process mitigate what she calls "one of the biggest systemic threats" to international human rights. She moved to London and joined Urgenda, where she now provides legal assistance to people around the world who want to take their governments to court over inadequate climate policies. She says she hopes the cases draw attention to the actions governments need to take to reduce the use of fossil fuels and to show how ordinary people will be impacted by climate change. —*Tara Law*

MICHAEL E. MANN

Paper straws alone won't save the planet

EVERYONE FACES CHOICES every day that carry a climate cost. Do we turn the lights on in the morning, or is the light of daybreak sufficient for finding matching socks? Do we feast on bacon and eggs for breakfast, or will a bowl of oatmeal suffice? There is a lot of talk these days about the need to lead lower-carbon lifestyles. There is also a lot of finger-pointing going on and, some argue, virtue signaling. But who is truly walking the climate walk? The carnivore who doesn't fly? The vegan who travels to see family abroad? If nobody is without carbon sin, who gets to cast the first lump of coal? If all climate advocates were expected to live off the grid, eating only what they could grow themselves and wearing only the clothes they'd knitted from scratch, there wouldn't be much of a climate movement. That level of sacrifice is unacceptable to most.

We don't need to ban cars; we need to electrify them (and we need that electricity to come from clean energy). We don't need to ban burgers; we need climate-friendly beef. To spur these changes, we need to put a price on carbon, to incentivize polluters to invest in these solutions. Though air travel accounts for only a paltry 2% of global emissions, whether or not climate scientists should fly consumes far more than 2% of my Twitter timeline. Unfortunately, sometimes doing science means traveling great distances, and we don't always have the time or luxury to take slower low-carbon options. We have a job to do, after all. But even still, a single scientist, or even hundreds of scientists, choosing to never fly again is not going to change the system. Purchasing carbon offsets for flights is a viable means of decarbonizing your air travel, for now. However, the true solution, pricing carbon, requires policy change.

There is a long history of industry-funded "deflection campaigns" aimed to divert attention from big polluters and place the burden on individuals. Individual action is important and something we should all champion. But appearing to force Americans to give up meat, or travel, or other things central to the lifestyle they've chosen to live is politically dangerous: it plays right into the hands of climate-change deniers whose strategy tends to be to portray climate champions as freedom-hating totalitarians.

THE BIGGER ISSUE is that focusing on individual choices around air travel and beef consumption heightens the risk of losing sight of the gorilla in the room: civilization's reliance on fossil fuels for energy and transport overall, which accounts for roughly two-thirds of global carbon emissions. We need systemic changes that will reduce everyone's carbon footprint, whether or not they care. The good news is we have tactics to bring environmentally friendly (and non-lifestyle-disrupting) options to fruition: pricing carbon emissions and creating incentives for renewable energy and reduced consumption. By putting a price on carbon, people can actually make money by reducing emissions, selling their services to corporations that are always looking for ways to cut costs. Never underestimate the resourcefulness of Americans when there's a dime to be made! But a price on carbon needs to be designed such that marginalized communities most at risk from climate impacts aren't adversely impacted economically as well.

This is why we really need political change at every level, from local leaders to federal legislators all the way up to the President. We need change not just at the breakfast table, but at the ballot box as well.

Mann is a professor of atmospheric science at Pennsylvania State University

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

THE MORE YOU UNDERSTAND HER WORLD, THE MORE POSSIBILITIES YOU SEE.

For Julia's family, early screening for autism made a lifetime of difference. Find out more at **ScreenForAutism.org**

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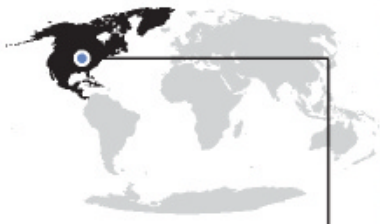


2050: THE FIGHT FOR EARTH

NORTH AMERICA

Difference in North America's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼	**0.54°**
1920s	▼	**0.21°**
1930s	▲	**0.07°**
1940s	▲	**0.18°**
1950s	–	**0**
1960s	▼	**0.15°**
1970s	▼	**0.19°**
1980s	▲	**0.29°**
1990s	▲	**0.49°**
2000s	▲	**0.82°**
2010s	▲	**1.19°**

KAMALA HARRIS IS TRYING NOT TO STEP IN IT. AS THE CALIFORNIA Senator turned presidential candidate tours a beef-and-produce farm in south-central Iowa on Aug. 11, a crouching campaign aide carefully walks a few feet ahead, pointing out the cow droppings littering the grass. The farmer strolling next to Harris, a bespectacled 49-year-old named Matt Russell, wants to talk about climate change. "Farmers and rural Americans, that's who's going to solve this," Russell says to Harris as the two stroll accompanied by a bevy of cameras in front of his red barn. "We have the land for renewable energy, and we have the farming systems to

The *Climate* Caucuses

Extreme weather in Iowa has forced 2020 U.S. presidential candidates to tackle climate change head-on

By Justin Worland/ Des Moines

Corn sits under a collapsed grain bin surrounded by floodwater in Thurman, Iowa, on March 23

sequester carbon."

The trip to Russell's 110-acre farm is becoming a habit for the Democratic candidates for President. Ohio Representative Tim Ryan visited before launching his campaign, and former Texas Congressman Beto O'Rourke stopped by in June. Russell has also chatted with Minnesota Senator Amy Klobuchar and South Bend, Ind., Mayor Pete Buttigieg elsewhere, and hopped on the phone with staffers for Massachusetts Senator Elizabeth Warren and former Vice President Joe Biden, among others. But he's hardly the only Iowan giving candidates an earful on climate change. Across the state, Democratic presidential hopefuls have heard from business owners whose

storefronts have flooded, mothers concerned about contaminated drinking water, and farmers who have lost harvests to a cycle of flooding and drought in the state. "There is deep concern about climate change across Iowa," says Michael Bennet, a U.S. Senator from Colorado currently running for the Democratic nomination. Survey after survey of Iowa Democrats have identified global warming as one of voters' top two issues, right after health care and ahead of immigration and the economy, among others.

In previous elections, climate change was essentially a nonissue. A Pew Research poll released three weeks after the 2008 Iowa caucuses found that just 1% of Americans ranked the issue as the nation's most important problem. Eight years later, Hillary Clinton and Donald Trump debated three times without facing a single question about climate change.

In the early stages of the 2020 campaign, things looked much the same: many Democratic campaigns offered little more than boilerplate support for a Green New Deal or an endorsement of the Paris Agreement. But over the course of the race, climate change has emerged for the first time as a top-tier presidential campaign issue. A slew of factors have contributed to the spike in national interest, from the activists pushing for a Green New Deal to the warning for urgent action embedded in the landmark Intergovernmental Panel on Climate Change (IPCC) report released last year by the U.N. to Washington Governor Jay Inslee's climate-focused presidential campaign, which raised the bar for other candidates. But climate's growing political clout is also due to the reality of daily life in Iowa, whose outsize importance in the presidential primaries has forced candidates to finally pay attention.

Since late April, all the major Democratic candidates have released comprehensive climate plans, addressing everything from the details of new research-and-development funding to how they would support other countries' climate efforts to how they would change permitting rules for new oil-and-gas pipelines. Several presidential hopefuls have proposed ideas tailored for Iowa, including new climate-insurance programs for farmers and new agricultural-research agencies. At multiple Iowa campaign stops in August, Ryan spoke at length about how farmers might one day receive government funding for capturing carbon dioxide in soil. New Jersey Senator Cory Booker has proposed funding programs to give farmers expanded access to renewable energy. "At every event, the candidates will talk about climate change," says Rob Hogg, an Iowa state senator from Cedar Rapids who has hosted town halls.

This is a glimpse of what's to come in U.S. politics, as the country contends with the creeping menace of climate change, from rising seas in Florida to wildfires in California. "Extreme weather events are waking people up," says Steve Shivvers, a retired agricultural equipment company CEO from Des Moines, who is active in local climate groups. The climate challenges Iowa faces today help explain why scientists and advocates are so eager for the issue's political salience to catch up to its ecological and economic

importance. In the long run, that may be inevitable. The question is whether the politics change radically enough before the climate does.

JIM LYKAM KNOWS DAVENPORT like the back of his hand. The Democratic state senator has lived in this city on Iowa's eastern border his entire life, and as he drives me down Davenport's empty back roads he recalls how it has been defined by its most powerful resident, the Mississippi River. Lykam, 69, points to the little adaptations that have sprouted over the decades, designed to make life on the river bearable: a dirt barrier one business owner constructed to prevent flooding;

NORTH AMERICA

1. Rising sea levels and worsening hurricane seasons threaten the **Mississippi River Delta,** a key economic driver for the U.S.

2. Droughts threaten **Mexico City**'s water supply and are causing the city to sink into the ground

3. Many areas on the U.S. East Coast suffer from flooding brought on by sea-level rise, including Virginia's most populous city, **Virginia Beach**

4. In **northern Alaska,** warmer and longer summers are melting the Arctic permafrost, releasing more carbon dioxide into the air, creating a vicious climate feedback loop

5. Longer and worse droughts threaten **California's Central Valley,** which accounts for a quarter of U.S. food production, and raise wildfire risk

6. A combination of hotter summers and more frequent, intense storms is threatening the livelihood of farmers and the viability of urban infrastructure in the **U.S. Midwest,** the traditional American heartland

elevated homes resting awkwardly on cinder blocks.

But this past spring, the combination of persistent rain and high water levels from fast-melting snowpack caused Davenport's levee system to fail. Downtown was inundated; the city's main thoroughfare was underwater. In total, the economic impact ran to some $30 million. Driving through town, you can still see the marks on doors and windows where water levels stagnated, in many cases for as long as two months. Parts of town were inaccessible for even longer than that. "They call them 100-year floods," says Lykam. "We've had three of them in the last 15 to 18 years."

The flooding in Davenport is just one example of how climate change and extreme weather have rocked Iowa. Throw a dart at a map of the state, and you're likely to hit a place that has flooded in recent years. In the past year alone, nearly 40% of Iowans have personally experienced anxiety over extreme weather or know a family member who has, according to a July survey from Climate Nexus in partnership with Yale and George Mason universities.

This isn't a surprise to scientists. Warmer air holds more moisture, which creates the potential for bigger storms, a problem that will leave few corners of the globe untouched. Across Iowa, the annual precipitation level averaged less than 33 in. during every decade of the 20th century. For the first half of this decade, average precipitation tops 36 in. An analysis from Iowa State University released earlier this year found a greater than 90% chance that global warming has driven the spike in the state's late-spring floods.

Voters across Iowa say the real-life effects of climate change have sparked a political awakening of sorts. Hogg, the state senator from Cedar Rapids, says record flooding in 2008 all but eliminated climate-change skepticism in the city. Recurring flooding contributed to the Iowa City council's recent decision to declare a climate crisis. The council made a commitment in August to reduce the city's greenhouse-gas emissions 45% by 2030. "It's not just about climate strikers," says Iowa City Mayor Jim Throgmorton, referring to the global movement of schoolchildren striking to call for action on climate change, and "not just about the IPCC report, but also about our own experience and own observation."

Flooding, and the extreme precipitation that caused it, has had a range of effects across Iowa, disrupting the cycles that farmers rely on to plant, grow and harvest their crops. This spring alone, extreme rain put 100,000 acres of farmland underwater in the state, resulting in tens of millions of dollars in damage to farmers. To top it off, July was exceptionally dry, throwing another wrinkle at farmers. By 2050, climate change threatens to erase all the gains made in agricultural productivity since the 1980s in the Midwest, meaning farmers will need to

CLIMATE OPTIMISTS

Kotchakorn Voraakhom

ARCHITECTURE

As a child, Kotchakorn Voraakhom liked to pry apart cracked pavement to let seedlings burst through Bangkok's sprawl. Now, the landscape architect designs park-size cracks to help Southeast Asia's megacities cope with climate change. Last year, her 11-acre project at Chulalongkorn University was Bangkok's first new public park in 30 years and won awards for its innovative design, which adds much needed "green lungs" to a dense metropolis and absorbs and reuses excess water plaguing Thailand's capital—one of the locations most at risk from worsening storms, floods and sea-level rise. This year, she will open a 36-acre plot with the capability of storing more than 2.5 million gallons of water. Her social enterprise, the Porous City Network, champions green interventions like these "thirsty" parks, as well as urban farming, green roofs and canal restoration to help vulnerable communities in Southeast Asia adapt to the coming deluge. —*Laignee Barron*

OPENING PAGES: DANIEL ACKER—BLOOMBERG/GETTY IMAGES; MAP BY JING ZHANG FOR TIME; ILLUSTRATION BY JACQUI OAKLEY FOR TIME

spend heavily or cut production, according to the National Climate Assessment, a report from more than a dozen U.S. federal agencies on the impacts of climate change.

Surveys have historically identified farmers as skeptical of climate science, but in Iowa there are hints that this may be changing. Aaron Heley Lehman, president of the Iowa Farmers Union, says climate has become a regular topic of conversation among farmers. Greg Franck, a self-described "farm boy" who lives in the Des Moines area but has worked in agriculture, described a recent meeting he attended in southwest Iowa, where farmers gathered to hear advice from federal government scientists on how to adapt to the effects of climate change. "There's hope there," he says.

THE SURGE OF INTEREST explains why Democratic candidates have become increasingly attuned to climate issues as they crisscross the state. At campaign stops in rural areas in the summer of 2019, the grim future for farms in a climate-changed world was a frequent subject of questions for presidential candidates. In urban areas, concerns about climate change often come up through discussions about water quality, since spikes in precipitation and flooding have swept chemicals in agricultural soil into the water supply. The town of Pacific Junction, near the state's western border with Nebraska, has become a frequent stop for Democratic presidential candidates since a levee breach nearly wiped it off the map earlier this year. "It's a reminder," Warren said on a Aug. 7 visit. "Everything is changing."

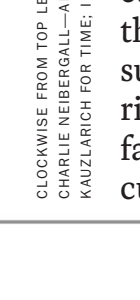
Conversations like these have translated into policy proposals. In April, O'Rourke was the first Democratic presidential candidate of the 2020 campaign to release a comprehensive climate plan, calling for a $5 trillion investment and the elimination of greenhouse-gas emissions by 2050. Many climate advocates lauded it, but they weren't his only audience. After the former Texas Congressman spent weeks on the trail in Iowa—including a visit with Russell—O'Rourke updated his white paper with more robust provisions to help farmers, including a funding stream for those who sequester carbon dioxide in their soil.

By the time the Iowa State Fair rolled around in August, at least seven Democratic candidates had put out similar proposals, from Booker's pledge to provide the Department of Agriculture with tens of billions of dollars in conservation funding to Bennet's idea to create a new research agency to focus on climate solutions for farmers. "Candidates are not just showing up and walking through the state," says Russell. "They're sitting down and listening."

None of this is to say that climate change will be the defining issue of the Democratic primary or that Iowans are now single-issue voters. And while the presidential hopefuls have all committed rhetorically to the cause—using language like "existential threat" and "climate crisis"—the strengths of their plans and commitments to the cause vary.

For many of the candidates, climate change has thus far remained a secondary concern in their careers with few of the members of Congress in the race having proposed comprehensive climate legislation before this year. And many still haven't met the demands of today's climate advocates. Klobuchar's

Clockwise from top left: Harris visits Russell on Aug. 11 at his farm in Lacona, Iowa; Russell talks with O'Rourke on June 7; Warren discusses agricultural practices with farmer Ron Rosmann during a campaign stop in Harlan, Iowa, on Aug. 8; President Trump tours an ethanol facility in Council Bluffs on June 11 with renewable-energy executives Mike Jerke, left, and Geoff Cooper



CLOCKWISE FROM TOP LEFT: JUSTIN SULLIVAN—GETTY IMAGES; CHARLIE NEIBERGALL—AP; MANDEL NGAN—AFP/GETTY IMAGES; MARK KAUZLARICH FOR TIME; ILLUSTRATION BY JACQUI OAKLEY FOR TIME

plans center on restoring initiatives begun during Barack Obama's presidency, short of what climate scientists say is necessary, and she has described natural gas as a "transition fuel," to the derision of environmental campaigners.

When Harris visited Russell's farm in mid-August, it was clear that the California Senator was more comfortable discussing run-of-the-mill agricultural issues than the specifics of the policy Russell suggested. "Farmers are innovators," Harris responded when Russell talked about farmers capturing carbon with their agricultural practices. "As they say, *farmers'* *almanac*. But really, it's about you who are so close to the ground really having an understanding of what it tells us and knowing how to then use all these natural elements in a way that is maximizing productivity." (Harris later released a comprehensive climate plan.)

Many Democrats, especially in Washington, believe bread-and-butter issues like health care and the economy should remain at the core of the party's message. That may be why members of the Democratic National Committee rejected requests from activists and candidates to sanction a debate focused entirely on

Hindou Oumarou Ibrahim

INDIGENOUS ACTIVISM

Hindou Oumarou Ibrahim, from the Mbororo pastoralist community in Chad, has spent the past 10 years working to bridge the gap "between the international decisions [on climate change] with the reality on the ground," she says. "I want to tell people what it is like in my country."

Traveling the nation to meet with indigenous groups, she kept hearing how much the environment was changing. "Each year I am seeing resources shrinking, and my people are struggling for survival," says Ibrahim. Leading up to the historic 2015 climate-change meetings in Paris, she was a key leader among indigenous groups that successfully lobbied to have their rights recognized, and she was selected to speak at the signing ceremony of the accords. Indigenous communities are among the most vulnerable to the impacts of climate change, but they can also offer solutions, says Ibrahim. "The traditional knowledge of indigenous people, that is centuries old, can help the world adapt."

—Jennifer Duggan

climate change. In a June statement, DNC chair Tom Perez seemed to dismiss climate as a pet issue for Inslee, saying he "could not allow individual candidates to dictate the terms of debates."

Still, of the two dozen voters I interviewed throughout Iowa in August, nearly every one brought up climate change unsolicited, from the Democrats staked out to catch the candidates' stump speeches at the Wing Ding dinner in Clear Lake to the crowd following Harris around the Iowa State Fair. Rachel Wilke-Shapiro, a preschool teacher in Des Moines and a Harris supporter, complained that the national narrative around climate change hasn't caught up with the reality she sees on the ground. "You have to explain to them why it's their 3 a.m. issue," she says. "People don't always tie it together."

IN THE DRIZZLING RAIN, Mitchell Hora walks me to the top of a 40-ft. grain bin on his family's farm in southeast Iowa's Washington County, where his family has worked for seven generations. Even to my untrained eye, it's clear that the Horas' 800 acres of corn and soybean crops are thriving while his neighbors' fields are dotted with patches of dead plants. The difference, he says, is that he changed growing practices in recent years, planting different crops on the same fields as the corn and soybeans he sells, a practice known as planting cover crops. He's reduced pesticide use and stopped tilling the land, which keeps key nutrients in the ground. All of these practices, he says, have improved his yield. It's good news for his farm, but it's also good news for the planet. Agriculture accounts for nearly 10% of U.S. greenhouse-gas emissions. Hora's new practices store carbon dioxide in the soil, meaning there's less of it in the atmosphere.

These are big changes for farmers accustomed to traditional growing practices. But the farmers implementing them aren't radical—Hora, whose family home is decorated with Bible verses and other religious items, makes clear that he's "not a hippie." The changes he has made, much like those of the state at large, are another sign that most people, regardless of their political leanings, are ready to talk about solutions. "We need to farm more sustainably," says Hora. "It's going to make us money and make us more economically resilient. And it's also good for the environment."

Democrats have tapped into that conversation. At least 10 candidates have proposed to offer farmers an additional income stream if they implement climate-friendly practices. "What we're seeing is a significant change in how the Democrats are engaging with farmers in rural America," says Russell.

This approach can provide a model for candidates to follow long after the Iowa nominating contest is done. Climate activists say Democrats have an opportunity to connect with voters by putting forth equivalent policies for communities across the country. "For far too long, climate policy has stayed in the realm of carbon and inanimate things," says Varshini Prakash, co-founder of the Sunrise Movement, an activist group that advocates for the Green New Deal. Politicians need to "tie it to what Americans are concerned about on a daily basis."

Many of the early primary states face climate-related challenges. In New Hampshire, whose voters go to the polls a week after Iowa's, a $9 billion recreation industry is vulnerable as ski runs melt early and local lakes face a potential decline in water quality. Scientists say parts of Nevada, the third state on the Democratic primary calendar, could be virtually unlivable by the end of the century; Las Vegas is warming faster than any other major city in the country. In South Carolina, the fourth state where Democrats will vote in 2020, coastal cities flood regularly and inland rivers are often inundated. Across the U.S., 9 in 10 Democratic voters say they are concerned about climate change, compared with 44% of Republicans, according to a national survey conducted by Climate Nexus, also in partnership with Yale and George Mason universities, released on Sept. 4. As in Iowa, the issue ranks second nationally only to health care as a priority among Democrats.

This is all no surprise to Inslee, who dropped out of the presidential race last month after running the most climate-change-centered campaign of any candidate in history. "We still have too many people who are trapped by the past," he told me over a beer in Polk City, Iowa. "Maybe 10 years ago, this was not a first-tier issue in voters' minds. But it is now." ◻

CLIMATE OPTIMISTS

Anne Simpson

FINANCE

When it comes to transitioning the world off fossil fuels, "money talks," says Anne Simpson, director of global governance at CalPERS, California's public pension fund. Simpson should know. Her employer ranks among the world's largest public funds, and she has used the sway that comes with CalPERS' more than $350 billion in investments to urge change. Early victories include pushing some of the world's biggest companies to disclose the risk climate change poses to their businesses. To extend her reach, Simpson helps lead Climate Action 100+, an investor-led initiative to engage in behind-the-scenes negotiations to demand the world's 100 biggest greenhouse-gas emitters change their ways. It's prompted companies like mining giant Glencore to cap coal production and oil-and-gas major Shell to commit to emission-reduction targets. To Simpson, investor activism is simply good business sense. "There's no business that can function without a healthy ecosystem," she says.

—Justin Worland

ILLUSTRATION BY JACQUI OAKLEY FOR TIME

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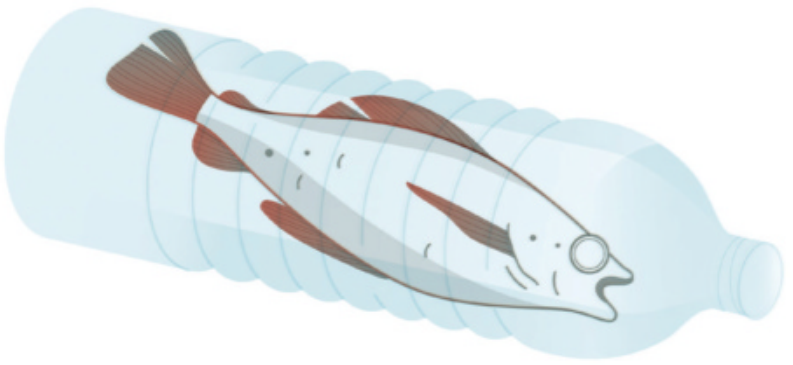
ANDREW ECCLES

PETER THOMSON

Preserving ocean life is essential to preserving human life

AS YOU'VE LIKELY HEARD, the ocean's health is in trouble. You're probably aware of overfishing and the harmful practices of fisheries driving a third of the planet's fish stocks toward extinction, and you surely know about the unconscionable amount of pollution, in particular plastic, that we dump in the ocean. But that's not the worst of it. The ocean is steadily warming; its oxygen levels are falling; and it is becoming more acidic, making conditions for life below the waves ever harder. Planet-warming greenhouse gases are the common enemy in that trio of changes. And by now we all know who has been creating those gases.

When you're a grandfather like me, and you care more about the well-being of your grandchildren than about your own creature comforts, there's no time for idle behavior. Last year, a report from the U.N.'s Intergovernmental Panel on Climate Change (IPCC) revealed that as global warming moves from 1.5°C above preindustrial levels to 2°, already observable trends—like the worsening of extreme weather, rising sea levels and loss of biodiversity—will be exacerbated. The report also indicated that when we go above 2° warming, we lose the planet's coral reefs, the vast nurseries that foster life in the ocean. We have no idea how the ocean's biome will function without them or what that will mean for our ecosystem. The predicament is that the planet is still on a devastating course toward 3° to 4° global warming.



AND YET, the IPCC report notes, it is still possible to stay at 1.5°. The good news is that we have a plan. It's multifaceted and requires a radical change of human production and consumption patterns, but it will succeed if people from all walks of life get behind it.

On a global level, we must exercise fidelity to the Paris Agreement; to the U.N.'s 2030 Agenda for Sustainable Development, including Goal 14 (conservation and sustainable use of the ocean's resources); and to the broad mosaic of multilateral agreements supporting them. Beyond that, it is vital that we establish new law for marine biodiversity beyond national jurisdictions. There is already a conference under way at the U.N. working on this issue, as there is a growing scientific consensus that we need to move toward a goal of protecting 30% of the ocean by 2030.

On an individual level, we all have a role to play as well. In my own work, one of my top priorities is putting an end to the billions of dollars in government subsidies worldwide that go mostly to industrial fleets chasing diminishing stocks of fish—and ensuring that the public funds saved are spent on beneficial measures like establishing and enforcing marine-protected areas. But everyone, from government officials to business executives to scientists to students, has the ability to make a difference. We can choose not to use nonessential plastics. We can consume seafood only from sustainable, legally caught stocks. We can get serious about reducing our carbon footprints, so we are on the right side of global efforts toward a carbon-neutral world by 2050.

Finally, we must scale up ocean science. We increasingly understand how little we actually know, and in these precarious times, it is essential that we have a firm grasp on whether we can afford to add new stressors to the ocean's ecosystem.

All of this, and much more, is necessary if we want to deliver on the plan to save life in the ocean. Considering that every second breath we take comes from the ocean, it is clear we must.

Thomson is the U.N. Secretary-General's special envoy for the ocean

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2050: THE FIGHT FOR EARTH

SOUTH AMERICA

THE Tipping Point

The Amazon rain forest has existed for 10 million years. It might not survive the next 100

By Matt Sandy/União Bandeirantes, Brazil

Photographs by Sebastián Liste for TIME

From the air, deforestation stretches as far as the eye can see, near União Bandeirantes in Brazil's western state of Rondônia

A wood truck en route from a protected region of the Amazon rain forest to a timber yard in União Bandeirantes

A lumberyard in Realidade, a town of 5,000 in the state of Amazonas, on the frontier of the rain forest

ON THE SOUTHERN CREST OF THE UNSCATHED Amazon rain forest, a storm inundates a wooden shack just off a sodden mud road. Inside, Antonio Bertola sits clutching a $1 beer under a painting of the Virgin Mary, his face ruddy and his clothes tatty from a lifetime of work on the land. The frontier town of Realidade is a mere speck on a changing map. To the north stretch hundreds of billions of trees and more than 1 million species never charted by man. To the south the muddy trail of human conquest reaches back for centuries. In a bittersweet tone of voice, Bertola recounts how his family of migrants had hungered for prosperity, security and, most of all, land to call their own.

Five decades ago Brazil incentivized millions of its people to colonize the Amazon. Today their logging yards, cattle enclosures and soy farms sit on the fringes of a vanishing forest. Powered by murky sources of capital and rising demand for beef, a violent and corrupt frontier is now pushing into indigenous land, national parks and one of the most preserved parts of the jungle.

Brazil's new President, Jair Bolsonaro, an unapologetic cheerleader for the exploitation of the Amazon, has the colonists' backs; he's sacked key environmental officials and slashed enforcement. His message: the Amazon is open for business. Since his inauguration in January, the rate of deforestation has soared by as much as 92%, according to satellite imaging.

As human activity in the Amazon ramps up, its future has never been less clear. Scientists warn that decades of human activity and a changing climate has brought the jungle near a "tipping point." The rain forest is so-called because it's such a wet place, where the trees pull up water from the earth that then gathers in the atmosphere to become rain. That balance is upended by deforestation, forest fires and global temperature rises. Experts warn that soon the water cycle will become irreversibly broken, locking in a trend of declining rainfall and longer dry seasons that began decades ago. At least half of the shrinking forest will give way to savanna. With as much as 17% of the forest lost already, scientists believe that the tipping point will be reached at 20% to 25% of deforestation even if climate change is tamed. If, as predicted, global temperatures rise by 4°C, much of the central, eastern and southern Amazon will certainly become barren scrubland.

Difference in South America's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼ 0.46°
1920s	▼ 0.51°
1930s	▼ 0.23°
1940s	▼ 0.02°
1950s	▼ 0.04°
1960s	▲ 0.09°
1970s	▲ 0.13°
1980s	▲ 0.40°
1990s	▲ 0.61°
2000s	▲ 0.79°
2010s	▲ 1.08°

The fires that raged across the Amazon in August helped illuminate something the world can no longer ignore. Inside the crucible of this ancient forest, relentless colonization is combining with environmental vandalism and a warming climate to create a crisis. If things continue as they are now, the Amazon might not exist at all within a few generations, with dire consequences for all life on earth.

To understand what is truly happening to the world's largest rain forest, TIME journeyed thousands of miles by road, boat and small plane this year to the front lines of deforestation. We spoke to loggers, tribespeople, environmentalists, ranchers and scientists. Despite growing outrage and threats by Western leaders to withhold trade with Brazil until Bolsonaro reverses course, on the ground we discovered the battle for the Amazon is close to being lost. The emboldened forces of development are running without restraint, and the stakes for the planet couldn't be higher. As the official formerly responsible for Brazil's deforestation monitoring, Ricardo Galvão, who was fired in August for defending his data on tree loss, told us, "If the Amazon is destroyed, it will be impossible to control global warming."

THE AMAZON IS 10 million years old. Home to 390 billion trees, the vast river basin reigns over South America and is an unrivaled nest of biodiversity. From blue morpho butterflies to emperor tamarins to pink river dolphins, biologists find a new species every other day.

The first humans migrated to the Amazon from Central America about 13,000 years ago. Up to 10 million tribespeople lived in fortified settlements, creating ceremonial earthworks, and cultivating fields and orchards. The Karipuna tribe roamed one enclave just south of where the Madeira River splinters into its tributaries amid rapids and waterfalls, in what today is the Brazilian state of Rondônia. The mouth of the Amazon sits 1,000 miles to the northeast. To the west and north the forest stretches into Bolivia, Peru, Colombia and Venezuela.

The European colonization of the Americas from 1492 saw settler plantations advance across the New World, bringing deforestation on a vast scale for farmland, firewood and houses. By the early 20th century, the world had lost trees that would have covered the

PHOTOGRAPHS BY SEBASTIÁN LISTE—NOOR FOR TIME; MAP BY JING ZHANG FOR TIME

SOUTH AND CENTRAL AMERICA

1

The **Peruvian Andes** have lost nearly half their glacier-ice surface area since the 1970s, impacting hundreds of thousands who rely on glacier water for agriculture and hydropower

2

Longer and more frequent droughts in **Honduras, El Salvador, Guatemala** and **Nicaragua** are among the factors driving people from their homes, northward to Mexico and the U.S.

3

In recent years, flooding exacerbated by sea-level rises caused damage of about 60% of the GDP of **Guyana,** where people live mostly on the coast

4

Deforested tropical lands (mostly in the **Brazilian Amazon**) account for more carbon emissions than any country except China and the U.S.

5

Flash flooding and landslides, like the 2017 **Mocoa** disaster that killed over 300 people, are now common on South America's northwestern coast

6

The **Patagonian ice fields** that straddle the border between Chile and Argentina are melting at some of the highest rates on the planet

'If the Amazon is destroyed, it will be impossible to control global warming.'

—Ricardo Galvão,

official fired by Brazilian President Bolsonaro from the agency that monitors deforestation

Amazon rain forest at least once over, but its rain forest remained largely intact. Not so its inhabitants. As with many of the more than 300 tribes that survive in Brazil, contact with outsiders decimated the Karipuna's numbers through illnesses such as measles and flu.

When the matriarch of the clan, Katicá Karipuna, was born about 70 years ago, her father led the only surviving faction of the Karipuna, which was still isolated from the wider world. Speaking with a soft lilt in her native language, she recounts that in those days, the birth of a girl caused celebration: the tribe would dance for days to the music of bamboo flutes to hail its endurance.

The 20th century saw more global tree loss than the rest of history. The Amazon, with vast mineral riches under its soil, finally came under threat. In 1964, Brazil's military dictatorship took power and decreed the "empty" jungle was a security risk. It went on to create the National Institute of Colonization and Agrarian Reform (INCRA) to conquer the forest and make it an agricultural stronghold.

In the early 1970s, the government ran television ads for a new mecca of cheap land—and freedom. Bertola and his family, farm laborers descended from Italian immigrants to the south of Brazil, joined millions flooding northward on newly built highways. "Everyone had the same dream," says Bertola, now 52. "It just meant deforesting it all." Men like Bertola are the forward cavalry of deforestation. Where main roads are built, hundreds of makeshift logging tracks splinter off in a fish-bone pattern. The land is demarcated, often illegally, and lots are typically sold for a few hundred dollars by *grileiros,* or "land grabbers," to poor farmers, who raze the forest and build communities.

Antonio Bertola and his family migrated to Rondônia in 1975, when it was still mostly forested

Over time, electricity and phone lines arrive, and the jaguars that threaten the cattle disappear from the landscape. Once infrastructure is in place, wealthy tycoons buy up the land to build cattle ranches or vast fields of soy. Bertola and those like him track the frontier northward into the virgin forest.

Once in motion, expansion is relentless. In Brazil—one of nine countries in the Amazon basin—an area larger than Texas has been cut. Here in the frontier state of Rondônia, ranching is king, much economic activity is illegal, and state agents are bought off or outmuscled. Agribusiness in Brazil generates nearly a quarter of the country's GDP, and the Amazon alone has over 50 million cattle.

For the Karipuna, the 20th century arrival of outsiders spelled further tragedy. The government sent an expedition into the forest in 1976 to find and assimilate the tribespeople, who—innocent and bare-chested—reacted joyfully at the moment of contact, dancing and holding hands with the outsiders.

The delight did not last. Katicá's voice drops with sadness as she explains that over the following months and years, she watched her husband, parents and other family members die one by one after being exposed to new illnesses. The survivors tried to flee into the forest, but only eight survived.

In 1998, the few surviving Karipuna were granted a protected territory about the size of New York City. Indigenous land makes up 23% of the Brazilian Amazon and is a bulwark against deforestation. It binds the tribes to the fate of the forest—if one dies, the other likely will too. The next year, a few settlers placed a marker at a spot deep in the forest just a few miles to the west of the Karipuna's territory. Early arrivals used rifle barrels to shoot pool, and sometimes each other. They christened their town União Bandeirantes, after raiders from Brazil's past who hunted for gold and enslaved tribes. United by hardship and a sense of destiny, the newcomers held church services in the open air. "Since we arrived, we understood our town to be a door God opened to bless us," says local pastor Arnaldo Bernardinho.

EARLY IN THE NEW MILLENNIUM, due to international pressure, Brazil got serious about stopping deforestation. That was felt keenly in União Bandeirantes. The authorities tried to evict the settlers and, when that failed, raids by the federal environmental regulator, IBAMA—along with the army—fined nearly every farmer in the settlement. One rancher, Edgar Gonçalves de Oliveira, says he was fined $40,000 but has no regrets. "I'm sure if you were in my shoes, you would have done the same," the 50-year-old told the IBAMA agent who fined him. "On the other hand, if I were in yours, I'd also be here doing your job." Even though the government rarely succeeds in collecting the fees, a fine can prevent the recipient from getting loans and provoke aggravation. Such moves worked: deforestation fell 83.5% from 2004 to 2012.

Yet the numbers crept upward once again as protections were relaxed. As the country fell into its worst ever recession in 2014, and amid a huge government corruption scandal, Brazilians became antagonistic to the established order. The ground was fertile for Bolsonaro, then a Congressman known mainly as a reactionary agitator who glorified the dictatorship. He ran for President as an outsider in 2018, his stated ambition to turn the Amazon into Brazil's "economic soul," giving free rein to agribusi-

ness giants, mining corporations, and developers big and small. Not one "square centimeter" of indigenous land would be designated if he became President, he said. Bolsonaro won 79% of the vote in União Bandeirantes in the October election. Soon after his inauguration, an empty logging truck without license plates trundled down a dirt road in União Bandeirantes, in the predawn gloom of a February day. A few days later, deep in the Karipuna's forest, the sound of a chainsaw was unmistakable. Ancient trunks next for the chop had been daubed with paint, and tire marks were rutted into the soil. Illegal loggers had been there minutes before.

Seen from the air, the Karipuna land is an emerald tapestry. But on every side of it, the forest is gone. Now, vast tracts of their territory are also being deforested, despite strict federal protections. The implications are grave. Much of Brazil's remaining forest exists in reserves.

Since coming to power in January, Bolsonaro has been ruthless in gutting protections, intervening to block an IBAMA operation against loggers in Rondônia, firing 21 of the agency's 27 state heads and creating a new body to pardon environmental fines. Across the Brazilian Amazon in recent months, tribal lands and national parks have been invaded like never before. "It's very sad, outrageous, to watch all the effort made over so many years by different governments being destroyed," says Marina Silva, a former environment minister who pioneered the fall in deforestation.

The Karipuna were already under threat. Last year, the equivalent of 70,000 tennis courts was razed. When TIME visited in February, the tribe felt isolated and fearful the new President would hasten their demise. "We are surrounded," Katicá said, gesticulating toward the settler town. "They are already on our territory. This is how they will arrive to exterminate us." Her fear is not misplaced. The Amazon is riven by deadly conflict over who controls the land. More than 1,300 people have been killed in such conflicts since 1985, and Rondônia is the crucible. There, hired gunmen ensure the interests of the powerful. Nilce de Souza Magalhães, a campaigner against a hydroelectric dam under construction in the state capital, was found dead beside the Madeira River. Adelino Ramos, a peasant leader in favor of land reform, was executed at a market in front of his children. And in western Rondônia, 18 rubber tappers have been killed since 2002 in protected reserves. "Today the fight has got so much worse," says their leader Agenor Firmiano da Silva. "We are on the verge of giving up."

Katicá Karipuna, the matriarch of the Karipuna people, fears the tribe's lands will be taken from them by force

Technically, the law is still on the forest's side. Indeed, the federal police raided União Bandeirantes in August to arrest illegal loggers. But with just five Karipuna families on a vast territory coveted by many, campaigners believe any ground ceded here could prove to be the first domino in an assault on the very principle of protected reserves. "If the Karipuna territory falls, it will be the first of many," says Danicley de Aguiar of Greenpeace.

Just down the road, 20 years after its beginnings as a gritty frontier, União Bandeirantes is showing signs of nascent wealth. Painted bungalows with neatly tended gardens dot its rural outskirts, and pastures home to nearly a quarter of a million cattle stretch to the horizon. At the evangelical church, in a chapel with 113 pews made from the trunk of a single angelim tree, the congregation weeps as a service reaches its climax. The pastor, Bernardinho, thanks the Lord the town is flourishing. "Now," he says, "we are prosperous."

As the seasons changed, crimson fires lighting up the night sky across Rondônia showed that prosperity will always come at a price. August is burning season, when Amazon farmers use a rare period of dry weather to set fires to clear fields ready to plant crops. But 2019 was different; satellite data showed more than 46,000 fires in the Amazon, an alarming 111% increase over last year.

Initially Bolsonaro was unflustered. After all, he had already dismissed preliminary 2019 deforestation figures as "lies" and sacked Galvão, the head of Brazil's space agency, INPE, for defending the data. "The President's accusation was very serious," says Galvão. "Scientists felt thrown into hell." Those preliminary INPE figures suggest a 92% increase in deforestation over the first eight months of 2019 compared with the same period in 2018. It is not yet clear if deforestation has returned to the heights of 1995 to 2004, but Bolsonaro's support for unfettered development appears to have made an impact. "The whole environmental structure of the country is being destroyed," says Paulo Artaxo, a Brazilian member of the U.N.'s Intergovernmental Panel on Climate Change.

The fires sounded alarms abroad. French President Emmanuel Macron and German Chancellor Angela Merkel spoke out. At an event in São Paulo, Bolsonaro replied, to cheers, that the two "did not realize that Brazil is under new management." He claimed developed nations were using an environmental agenda to "take over Brazil" for its natural resources. "Sovereignty of the region and its riches is what is truly at stake," the President said in August.

Late that month, aided by rare atmospheric conditions, a vast plume of black smoke drifted from the Amazon and darkened afternoon skies as far away as São Paulo, over 1,700 miles to the southeast. As dramatic images of the blackout and fires proliferated worldwide, protests broke out across Brazil and in cities around the world. And after the G-7 leaders held emergency talks during their summit in France, Bolsonaro relented. "I have a profound love and respect for the Amazon," he said in a televised address. "Protecting the rain forest is our duty." He immediately dispatched warplanes and army units to Rondônia to fight the blazes.

Few are convinced he means it. "If the government believes we live on an island, we won't succeed," says Blairo Maggi, a billionaire tycoon known as the "soy king." "He created an unfavorable environment for our exports." France and Ireland have threatened to sink the E.U.'s trade deal with the South American trading bloc Mercosur unless Brazil resolves the "international crisis," and Norway and Germany have halted donations to the Amazon Fund, the largest private investment in saving the rain forest. Congressman Alceu Moreira, the leader of the powerful agricultural caucus in Brazil's National Congress calls European pressure simply "a commercial war." He says, "Brazil won't take into consideration the whims of those who seek to control us from the outside."

AT LEAST 427 SPECIES of mammals live in the Amazon rain forest, but one now dominates in terms of raw numbers: the cow. Cattle farming accounts for up to 80% of deforested land. In 2018, Brazil exported some $6 billion worth of beef, more than any other country in history. While stringent supply-chain standards make Europe a difficult market for Amazon producers, countries in Africa and Asia—particularly China—are less discerning.

The law requires small farmers to maintain 80% of the forest on their land, but the penalties do not deter livestock farming. Oliveira, the rancher in União Bandeirantes, cannot legally sell his cattle owing to embargoes placed by the environmental regulator. Instead he sells animals at a discount to a middleman, who sells them to Frigon, the biggest slaughterhouse in the state, without a problem. Slaughterhouses often turn a blind eye to the source of cattle that arrives via third parties—a state of affairs the owner of Frigon, João Gonçalves, happily admits exists.

Striding confidently around his vast plant as a line of cow carcasses is gutted by white-clothed employees on his production line, Gonçalves talks with a lifetime of certainty about the benefits of expansion into the Amazon. His slaughterhouse will soon be the biggest in Brazil, according to the company, killing a cow every eight seconds. His company exports nearly 40,000 tons of beef each year to Hong Kong, Egypt, Russia, Saudi Arabia, Switzerland and Denmark.

André and Daniel, two Karipuna tribespeople, on an expedition into their protected land to examine the damage from illegal loggers

The Assembly of God's Mission evangelical church, the largest church in União Bandeirantes, Rondônia

A worker changes a saw in a timber yard in the frontier town of Realidade, in the Amazonas state

A slaughterhouse in Jaru, Rondônia, that, after its current expansion is complete, will kill one cow every eight seconds

Indigenous children bathe in the Jaci Paraná River on the Karipuna reserve, an enclave surrounded by deforestation

Ashen trees near Realidade in August. The number of fires in the first eight months of 2019 was more than double the same period in 2018

Throughout the industry, accountability is scarce. The Brazilian company JBS, a global leader in beef production, has been fined millions of dollars for buying cattle from farms under embargo. American agribusinesses Bunge and Cargill are among the largest players in the export of 14.9 million tons of soy from the Amazon annually, used primarily as a livestock feed. They have also been fined millions for sourcing soy from off-limits areas.

For at least some working in the Amazon, the environment is simply irrelevant. "We came here to open up this region, so now let's leave it? It's not logical, is it?" asks Gonçalves, the slaughterhouse owner. "We came here to deforest, to clean," he adds. "In the next 100 years, the Amazon will all be open. It's a matter of time, right?"

Yet the consequences are now becoming apparent even to some of Bolsonaro's supporters in União Bandeirantes. Oliveira, the rancher, says the stream at the bottom of his land has dried up. On the eastern edge of the Amazon, shrubland has emerged. And in deforested areas in the south, temperatures rose at more than double the global average.

WITH TENS OF BILLIONS of trees already gone, the region is warming fast. Droughts and floods are more common, and the dry season has grown by six days per decade since 1980. Trees play a crucial role in putting water back into the atmosphere, and their absence means less rainfall and higher temperatures.

Carlos Nobre and Thomas Lovejoy, leading authorities on the Amazon and climate change, believe all of it—deforestation, the fires lit by ranchers that spread hundreds of meters through forest, and the impact of global temperature rises—might soon push the rain forest past its tipping point. Current projections by the U.N. show the earth heading for heating of up to 5°C this century—far higher than the 2°C assumed by Nobre's research. If that happens, that forest will be lost forever. "In 10 or 20 years, we will make a final diagnosis," says Nobre. "If this process continues, it becomes irreversible."

The forces set in play in the Amazon could have serious global consequences. The forest stores up to 120 billion metric tons of carbon, equivalent to almost 12 years of global emissions at current rates. If cleared, much of that will go into the atmosphere. That alone could push the global climate beyond safe limits.

The Amazon tipping point could also lead to a cascade of other potential climate tipping points. Forest dieback is strongly interconnected with other phenomena such as the melting of the Greenland ice sheet, which would cause sea levels to rise, and the degradation of frozen soil in the Arctic known as the permafrost, which would release greenhouse gases held in the ice as well as long-dormant diseases.

Scientists believe that these changes combined could result in runaway global warming that humans would find impossible to reverse.

TO AVOID THE WORST-CASE SCENARIO, the heart of the Amazon must be spared. Although 19.8% of the 1.5 million sq. mi. of the Brazilian rain forest has been conquered, mostly along its south and east, swaths of the west and center remain intact. But that might soon change. From the vanquished terrain of Rondônia, a decaying highway roves north into the forest. The BR-319 bisects the Purus-Madeira basin, one of the most preserved parts of the forest, where wildlife such as nocturnal two-toed sloths, woolly monkeys and teju lizards live undisturbed. The military inaugurated the highway in 1973 to connect Porto Velho, the capital of Rondônia, with Manaus,

the largest city in the Amazon. Yet within a few years, the 550-mile road fell into disrepair, reclaimed by grass and weeds. Jaguars and anacondas would cross the asphalt, flecked with meter-wide potholes and rusting road signs.

Now the BR-319 is stirring again. On this road lies Realidade, which frontiersman Bertola has called home for the past six years. There, the lumberyards are opening fast and the telltale fish-bone tracks already mark the jungle. Today, Realidade has 21 evangelical churches and three chainsaw repairmen. It is a harsh life in the midst of the forest; the newly arrived face the threats of malaria, deadly snakes and persistent torrential rain. At times it feels like the forest is fighting back against the invasion. "Everyone who comes up this road comes with a dream to find wealth," Bertola says with a sigh. "Here, they only find suffering. But we do not desist."

União Bandeirantes was founded in 1999, in a protected rain-forest area. It's a hub for illegal deforestation

Bertola, like around 5,000 fellow travelers in recent years, moved in anticipation that the BR-319 would be repaved. But, despite much debate, nothing was done, and the road deteriorated. In July, Bolsonaro committed to repaving the highway "with all certainty." But paving the road will "transform the geography of deforestation" by creating easy access to an area of forest bigger than Germany and Holland combined, according to Philip Fearnside, a professor at the National Institute of Amazonian Research. Fearnside co-authored a recent study that shows paving the road and another highway, the AM-364, would lead to a 277% increase in deforestation in the region by 2050. "This highway will accelerate us toward the tipping point because it cuts in half a very rich water basin and an area of high biological value," says Ricardo Mello, head of the World Wildlife Fund's Amazon Program.

Those praying for the rehabilitation of BR-319 aren't thinking about that bigger picture. Bertola builds houses for newcomers out of wood from the forest. He's bought a plot deep in the jungle and plans to deforest half of it, build a cattle enclosure and buy livestock. He hopes Bolsonaro will help him achieve his goal of starting to earn from the land in 2028. By then, the logging boom will have subsided and cattle ranches will take over. Eventually, this too will become soy fields. Ultimately, Bertola says, he will put his family first.

But if the worst happens, it will be felt first by those forging livelihoods on the frontier. The decline in rainfall would parch farmland and cause widespread drought. Lower river levels would have a knock-on effect on boat transport, the fishing industry and hydroelectric power generation. If the tipping point is reached, the Amazon's economy would be largely destroyed. But the wheels of expansion continue turning unabated. In February, near the foot of the BR-319, not far from where the asphalt turns to dust, the piercing sound of drills rings out over the forest. The metal frame of a new slaughterhouse is already taking shape next to the road.

In the Karipuna's reserve, the once distant hum of chainsaws and gunshots grows louder. Katicá worries every day about the future. The invaders, she says, "do not understand that they are in a place that is not their own." But it is the prospects facing her grandchildren that worry her most; she cannot imagine a future for them without the forest.

The tribal lands are her world, she says. As the sun glows through the branches in a clearing near her village, and spider monkeys scamper in the canopy above, her eyes remain alive with defiance. "If I die," she says, "I die here." —*With reporting by* SHANNA HANBURY, FLÁVIA MILHORANCE *and* ALICE KASZNAR/RIO DE JANEIRO. *This story was supported by the Pulitzer Center* □

Marcelo Firmiano da Silva with his children on the Maracatiara reserve in western Rondônia. Rubber tappers, like indigenous tribes, provide a bulwark against deforestation on their protected land, but since 2002, 18 of his colleagues have been killed

ANNE HIDALGO

Our cities cannot become climate sanctuaries for the rich

CLIMATE DISASTERS have rarely been so devastating. Across Europe, temperatures have reached new heights. Our planet has endured an extraordinarily hot summer, sea ice continues to melt at an alarming rate, and fires raging through the Amazon confirm our worst fears.

The good news is that we are finally talking about it. But talking is not enough. Our survival depends on action. These weather events did not come about by pure chance. We are responsible.

Today, the young are showing us the way forward. Many have listened to Greta Thunberg's call to action. High school activists are marching in our cities, challenging their leaders to act once and for all.

I hear them, I am listening. It is my responsibility as a politician to give concrete answers. Individual action will not be enough unless policymakers create the conditions for collective change.

CHANGE IS STILL POSSIBLE. As chair of the C40 organization—a group of mayors representing many of the largest cities in the world—I have seen that cities can act together, even when countries refuse to do so. Within our network, hundreds of cities around the world have committed to cutting their carbon emissions.

But we will fail if we turn our cities into climate sanctuaries disconnected from the rest of their countries and reserved for the richest citizens. How do we design a transformation to benefit everyone?

In Paris, I have been fighting against pollution for a long time by gradually limiting the city's exposure to the most polluting vehicles and reducing parking spaces in the streets. It has not been easy, but I am deeply convinced that the environment is a concern for everyone in society.

We need to take everyone into account to find the best solutions. My vision for Paris is as a green city where we can all breathe fresh air, share open space and enjoy our lives.

That is why we are adapting our city to give more space to pedestrians and bicycles. For instance, the Seine's banks—urban highways in the heart of Paris—have been converted into promenades. On Sundays, entire neighborhoods turn into pedestrian zones. And 620 miles of bike lanes will be completed by the end of this year. Wherever possible, in streets, squares and playgrounds, we are removing asphalt to give space back to nature. Soon, the Eiffel Tower will sit in the middle of a large park. With tree-planting programs, real urban forests will act as the lungs for neighborhoods across the city.

This is the city we want to show the world during the Summer Olympics in Paris in 2024. In times of crisis, we need such major unifying events to stimulate dialogue, facilitate an exchange of ideas and push us to meet challenges. We have a clear deadline to work toward, and we plan to host the most environmentally sustainable Olympic Games in history.

For that, we will build little and only when it will be useful to residents. Public transport will be at the heart of the project, 100% green energy will be used, and single-use plastic will be banned. This legacy will benefit Parisians and everyone who loves Paris.

The situation is urgent, but I am confident because I know I am not alone in this battle. There are more and more of us fighting for a different vision of the world—a world that takes care of our most precious resources: the air we breathe, the water we drink and the places we share.

Hidalgo has served as the mayor of Paris since 2014

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

© Center on Addiction | Partnership for Drug-Free Kids

Is giving my daughter money
to buy food helping her buy drugs?

When your child struggles with opioids,
you struggle with impossible questions.
DrugFree.org Where families find answers

Partnership™
for Drug-Free Kids

2050: THE FIGHT FOR EARTH

ANTARCTICA

Keep Antarctica *on Ice*

HUMANS WERE NOT AROUND TO SEE ANTARCTICA in the good times, tens of millions of years ago, when it was home to palms and baobab trees, reptiles and marsupials. It had some of the same mountains it has today, some of the same valleys and inlets. But it didn't have the same address.

Long ago, Antarctica was located in the mid-latitudes, once part of the supercontinent Gondwana, until it slowly broke away, leaving continental kin like Africa and South America behind. It then went its own way, carried off by continental drift at just 1 to 2 in. per year, until it wound up where it is today, banished by tectonics to the bottom of the world.

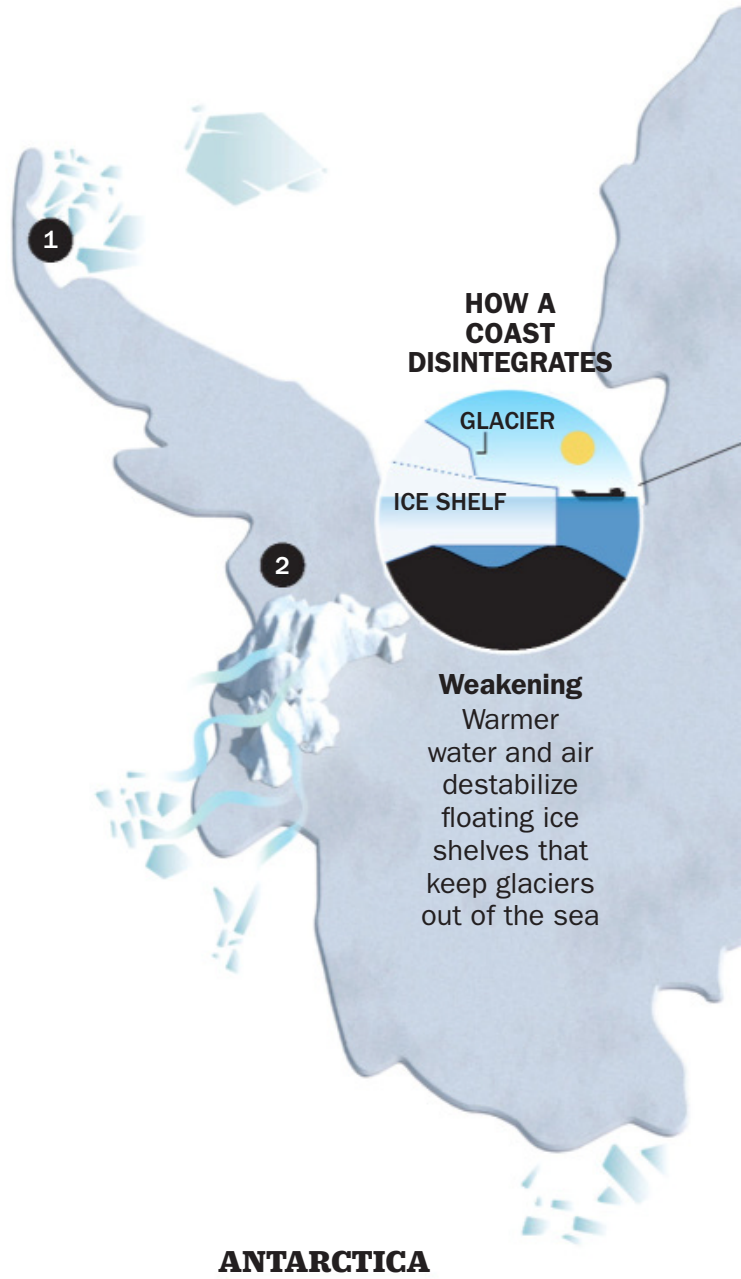
There, the 5.4 million sq. mi. continent—larger than Australia's 2.9 million and Europe's 3.9 million—gets its sunlight only laterally, never vertically, and will thus ever be sunk in a deep freeze, until the same crustal migration carries it to a kinder part of the planet. For now, Antarctica is buried under a layer of ice that averages 7,100 ft. deep—or 1.3 miles. That dense covering represents 90% of all the world's ice and 70% of its fresh water, locked in a wasteland.

Only it's not a wasteland. Antarctica is home to penguins, seals, visiting whales, gulls, krill, albatross and more. Like all continents, it has its complex food web; like all continents it has its seasons and its landscapes and its peaks and valleys. They aren't the seasons we might like; it's not a landscape we could survive. But our species is not the sole measure of a continent's worth.

What's more, all of that entrained ice is serving us well. In a world in which Antarctica were situated elsewhere, the ice would be water and the oceans would be deeper, inundating what are now our coasts. It wouldn't have mattered to us if we'd been born into that world. If there had been no Florida in the first place, we never would have built a Miami. But there is, and we did. And now, thanks to our industrial enterprise and our fossil-fuel gluttony, we're raising the temperature and melting the ice. The Arctic is already vanishing and the Antarctic is following, threatening us with the very inundation the polar ice spares us. The numbers here tell an alarming story—and it's a story we are every day authoring. —JEFFREY KLUGER

Difference in global average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼ 0.38°
1920s	▼ 0.25°
1930s	▼ 0.07°
1940s	▲ 0.04°
1950s	▼ 0.06°
1960s	– 0°
1970s	▲ 0.06°
1980s	▲ 0.35°
1990s	▲ 0.59°
2000s	▲ 0.94°
2010s	▲ 1.21°



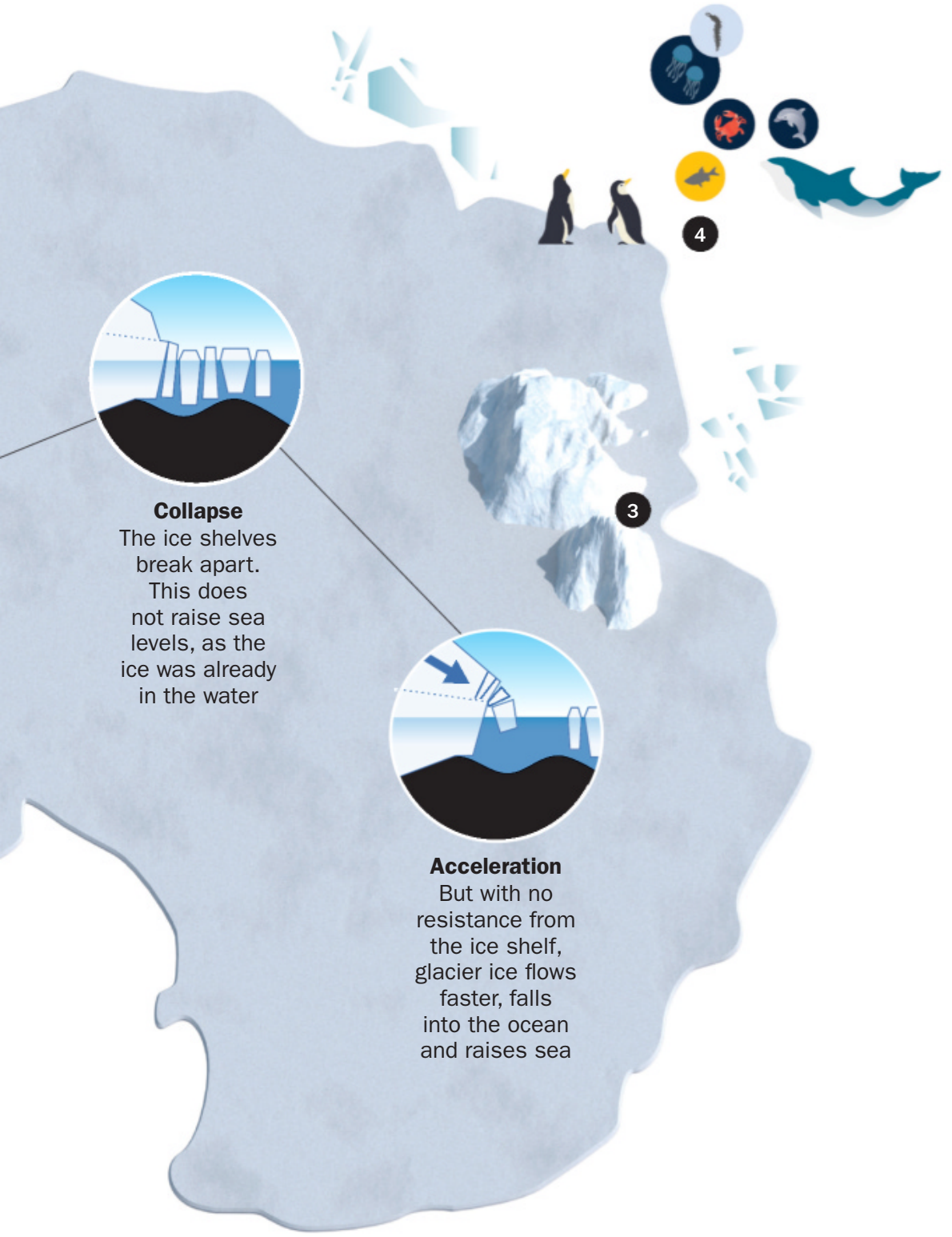
ANTARCTICA

1 Major ice shelves on the peninsula have collapsed, including the **Larsen B ice shelf,** the size of Rhode Island, which disintegrated in 2002

2 The **Wilkins ice shelf** has been breaking since 1998, while major glaciers farther south are retreating; the **Thwaites glacier,** for instance, is currently a backstop to other neighboring glaciers—if it disappears, that could create a cascading effect

3 **East Antarctica** has long been more stable than West Antarctica, but scientists are finding that even the titanic ice sheets of the east are shrinking

4 Populations of Antarctic krill—a key food source for whales, seals and penguins—have shrunk dramatically in recent decades, probably because the krill's **ice habitat** is melting

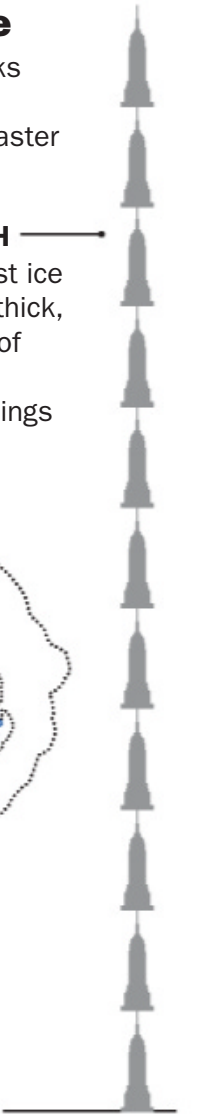

4
3
Collapse
The ice shelves break apart. This does not raise sea levels, as the ice was already in the water
Acceleration
But with no resistance from the ice shelf, glacier ice flows faster, falls into the ocean and raises sea

Continental imbalance

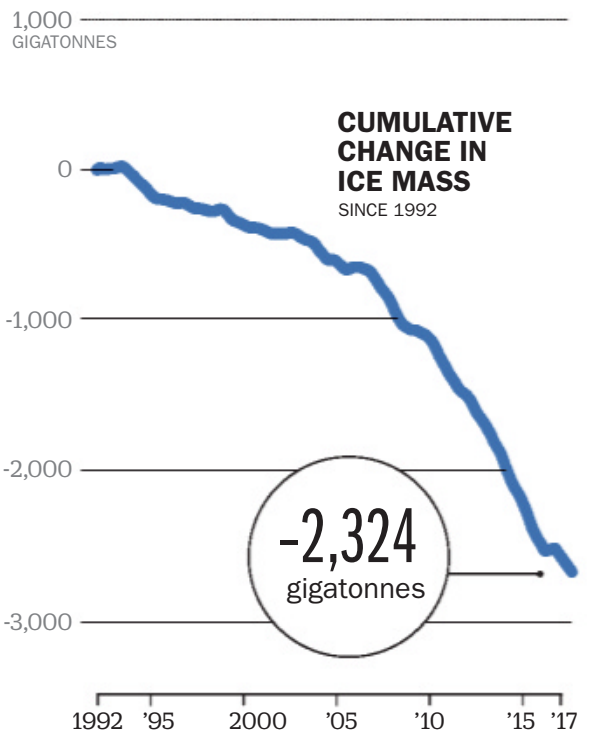
Antarctica's ice grows and shrinks seasonally. But, particularly in western regions, ice is melting faster than it is accumulating

THE EXTENT
Antarctica's area roughly doubles each winter from coastal sea ice

THE DEPTH
The deepest ice is 3 miles thick, the height of 11 Empire State Buildings



THE LOSSES
Antarctic ice melt has accelerated. The rate of recent ice loss is five times the rate of 20 years ago

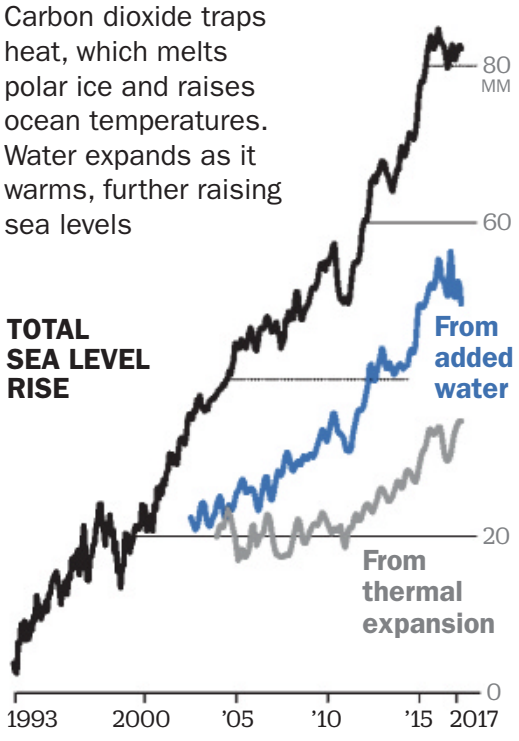


49 gigatonnes
of ice shed annually from 1992 to 1997

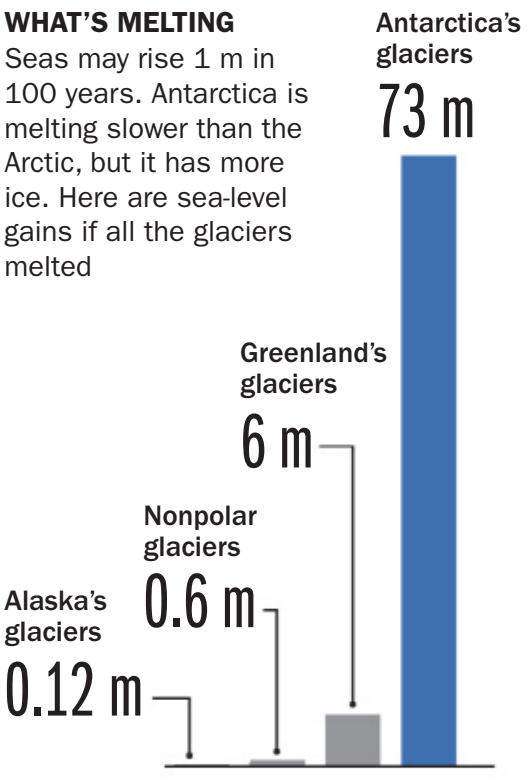
219 gigatonnes
of ice shed annually from 2012 to 2017

Behind earth's rising seas

SWELLING WATERS
Carbon dioxide traps heat, which melts polar ice and raises ocean temperatures. Water expands as it warms, further raising sea levels



WHAT'S MELTING
Seas may rise 1 m in 100 years. Antarctica is melting slower than the Arctic, but it has more ice. Here are sea-level gains if all the glaciers melted



SOURCES: NOAA NCWCP LABORATORY FOR SATELLITE ALTIMETRY; NASA; USGS; NSIDC; IMBIE; NSF; SCIENTIFIC AMERICAN; ANDREW SHEPHERD, UNIVERSITY OF LEEDS; THEODORE SCAMBOS, UNIVERSITY OF COLORADO BOULDER

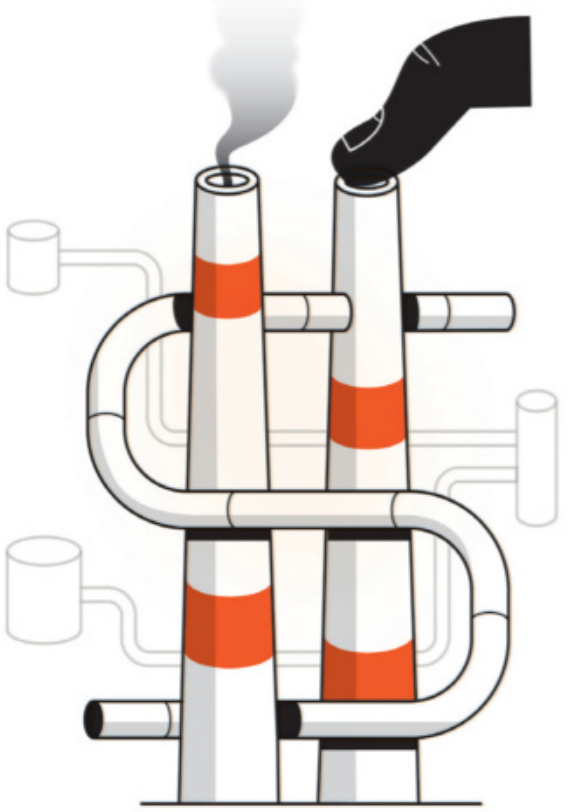
HIROMICHI MIZUNO

The pension fund trying to change the world

THERE'S A LOT of responsibility that comes with managing a fund with $1.5 trillion in assets—a responsibility that Japan's Government Pension Investment Fund (GPIF), the largest pension fund in the world, faces every day. We have more than 5,000 stocks and 3,400 bond issuers in our portfolio, and the fund is designed to operate with a 100-year, multigenerational time frame.

Unlike investors with a shorter time horizon, we consider climate change to be a systemic risk affecting the entire range of our investments, one that can't be eliminated simply through diversification.

We could certainly reduce the carbon footprint of our portfolio dramatically if we divested from certain carbon-intensive industries, but this would only result in a transfer of ownership to investors who are not as concerned about climate issues and thus would do little to contribute to a less carbon-intensive world. Our approach, rather, is to encourage companies with a large carbon footprint to adopt a more sustainable business model. I believe long-term investors have a duty to support corporate leadership that is embarking on a low-carbon transition.



A BETTER WAY for us to deal with climate change is to integrate environmental, social and governance (ESG) issues throughout our whole investment process. We require all our asset managers to include these criteria in their investment analysis and decisions. Our equity portfolio managers are also obligated to engage with the companies they invest in on critical environmental issues.

In addition, over the past two years, Japan's pension fund has been aggressively investing—a total of around $32.8 billion as of the end of March 2019—in funds that take into account ESG factors. Last year, we selected two climate-focused benchmark indices that incorporate two key elements: They seek out companies with high carbon efficiency within an industry. They also highly value companies that proactively disclose climate information. We don't divest; we rebalance and engage.

We recently began using ESG factors in making decisions for our bond portfolio as well. In partnership with the World Bank Group, we have worked to cultivate the green bond market. Encouragingly, we've seen signs that these bonds are becoming more mainstream.

Skeptics question the effect of ESG investment on financial performance, but we emphasize that climate change and other ESG-related risks materialize only over the long term. Assessing the financial validity of ESG investing over a span of only a few years is therefore misleading. Having said that, almost all our ESG indices have outperformed the market since inception.

Since our ESG investment began in earnest in 2015, we are encouraged that our efforts have reverberated throughout the business community—particularly in Japan, where many companies are making a dramatic push to improve their ESG profile.

The GPIF of Japan will continue on this path, but we cannot do it alone. We call for deeper collaboration among shareholders, financiers and policy-makers everywhere. Together, we can work toward the goal of creating a more sustainable world for future generations.

Mizuno is the executive managing director of Japan's Government Pension Investment Fund

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

Tears From a Volcano

Uniquely American stone ignites romance

On May 18, 1980, the once-slumbering Mount St. Helens erupted in the Pacific Northwest. It was the most impressive display of nature's power in North America's recorded history. But even more impressive is what emerged from the chaos... a spectacular new creation born of ancient minerals named Helenite. Its lush, vivid color and amazing story instantly captured the attention of jewelry connoisseurs worldwide. You can now have four carats of the world's newest stone for an absolutely unbelievable price.

Known as America's emerald, Helenite makes it possible to give her a stone that's brighter and has more fire than any emerald without paying the exorbitant price. In fact, this many carats of an emerald that looks this perfect and glows this green would cost you upwards of $80,000. Your more beautiful and much more affordable option features a perfect teardrop of Helenite set in gold-covered sterling silver suspended from a chain accented with even more verdant Helenite.

EXCLUSIVE FREE Helenite Earrings -a $129 value- with purchase of Helenite Necklace

Limited Reserves. As one of the largest gemstone dealers in the world, we buy more carats of Helenite than anyone, which lets us give you a great price. However, this much gorgeous green for this price won't last long. Don't miss out. Helenite is only found in one section of Washington State, so call today!

Romance guaranteed or your money back. Experience the scintillating beauty of the ***Helenite Teardrop Necklace*** for 30 days and if she isn't completely in love with it send it back for a full refund of the item price. You can even keep the stud earrings as our thank you for giving us a try.

Helenite Teardrop Necklace (4 ¼ ctw) ~~$299~~* ..... Only $129 +S&P

Helenite Stud Earrings (1 ctw) ..... $129 +S&P

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** Special price only for customers using the offer code versus the price on Stauer.com without your offer code.*

- **4 ¼ ctw of American Helenite and lab-created DiamondAura®**
- **Gold-finished .925 sterling silver settings**
- **16" chain with 2" extender and lobster clasp**

Limited to the first 1600 orders from this ad only

4 carats of shimmering Helenite

★★★★★

"I love these pieces... it just glowed... so beautiful!"
— S.S., Salem, OR

Necklace enlarged to show luxurious color

Stauer... *Afford the Extraordinary.®*

2050: THE FIGHT FOR EARTH

OCEANIA

No person is an island

The people of the South Pacific are uniquely threatened by climate change

By Angelina Jolie

THE TECHNOLOGICAL SOPHISTICATION OF modern life masks a simple reality: we all need oxygen, water and food to survive. But the divide between those who have the resources they need to exist and those who don't only continues to grow. And with the growing specter of climate change, people who live in vulnerable regions like Oceania—the countries and territories within the southwest Pacific Ocean—face the loss of their livelihoods, homes and future.

Twenty-four million people globally are displaced within their countries each year on average because of climate- and disaster-related causes, and it's only getting worse: the likelihood of any of us being displaced in this way is twice what it was in the 1970s. This comes on top of unprecedented levels of forced displacement worldwide because of conflict and persecution.

If unchecked, climate change and environmental degradation have the potential to exacerbate global displacement beyond anything humanity has ever experienced, with low-income countries and fragile states set to bear the brunt of the impact. According to the Intergovernmental Panel on Climate Change, a rise in sea levels by 1 m could cause Bangladesh to lose an estimated 17.5% of its land. A similar rise in sea level could put 3 million people in northern Nigeria at risk of displacement. How are we preparing for this? Better still, how are we working to prevent it?

More than 40 million people live in Oceania. In 2018, the region—which spans Australia and the islands that make up Micronesia, Polynesia and Melanesia—had its third warmest year on record. Many of the islands

Difference in Oceania's average temperature (°C) by decade, relative to a 1910–2000 average

1910s	▼ 0.24°
1920s	▼ 0.30°
1930s	▼ 0.19°
1940s	▼ 0.27°
1950s	▼ 0.11°
1960s	▼ 0.01°
1970s	▲ 0.14°
1980s	▲ 0.42°
1990s	▲ 0.53°
2000s	▲ 0.73°
2010s	▲ 0.93°

In Funafuti, Tuvalu, the home of the Salesa family—from left, Vaisepa Tiki, Faleata Salesa, Ionatana Laumua (10 months old) and Taninelu Salesa—floods four or five times a month when the high tide comes in

Wu Changhua

BUSINESS

Back in 1990, when Wu Changhua first started documenting environmental issues as a young photojournalist in Beijing, she thought it was "all about planting trees and keeping the streets clean." Few policymakers in China knew any different, prioritizing unbridled growth at any cost. As she moved into business and advocacy, Wu learned fast, and her patient cajoling helped shepherd the rehabilitation of the world's No. 2 economy from an environmental pariah to a champion of green issues on the global stage. It involved tact. While international institutions publicly scolded China for its belching factories and toxic waterways, Wu worked with officials behind the scenes to help infuse global standards into industry and urban planning. "For a long time we were ignored, marginalized, but now we're pretty much mainstream," says Wu. Now CEO of the Future Innovation Center, Wu continues to advise governments and corporations on sustainability strategy and the low-carbon economy.

—Charlie Campbell

PHOTOGRAPHS BY CHRISTOPHER GREGORY FOR TIME

CLIMATE OPTIMISTS

Hilda Heine

GOVERNANCE

Climate change is literally at Marshall Islands President Hilda Heine's doorstep. "Around my house, I have had to build a seawall," she says, "because there is water coming over from the shoreline." The sea is encroaching quickly on President Heine's low-lying Pacific island state, and over the past four years, the government has had to put in place adaptive measures like building coast-protection systems and seawalls, she says. Heine has taken to the international stage to share the story of her country and the difficult decisions her compatriots are facing, including the possibility of relocating. She chairs the Climate Vulnerable Forum, a group of some 50 countries particularly in peril from climate change, despite having contributed a pittance to atmospheric greenhouse gases. Heine is adamant that everyone needs to take action; she's committed the Marshall Islands to going carbon-neutral by 2050, and the nation was the first to submit its emissions pledge under the Paris Agreement.

—Jennifer Duggan

OCEANIA

1

Warmer and more acidic waters, brought on by climate change, have caused mass coral-bleaching events in recent years, harming huge swaths of the **Great Barrier Reef;** it's devastating for wildlife, fisheries and Australia's tourist industry

2

The nations of **Kiribati** and **Tuvalu,** both comprising numerous low-lying islands and atolls scattered in the Pacific Ocean, are on the front lines of the climate crisis; sea-level rise has already affected as many as half the families living on some islands, like Kiritimati

3

In November 2018, thanks to drier-than-normal conditions and a heat wave, hundreds of wildfires—or bushfires, as they're called locally—blazed across **Queensland;** in Australia's recorded history, there had never before been such extreme fires in the eastern part of the country

4

Recent years have seen grape harvests fall by 30% to 50% in some of Australia's most important **winemaking regions,** thanks to longer and more intense droughts that threaten the $6 billion wine industry, among the world's biggest

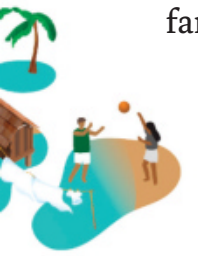
that make up this region are particularly vulnerable to rising temperatures and sea levels, two of the many consequences of climate change. If these places are lost under the waters or become uninhabitable, humanity will lose so much: wildlife, natural resources, unique cultures, languages and values. But the people who live there will lose everything.

From my experiences meeting refugees all around the world, whenever people are displaced, their first instinct is to seek a practical local solution inside their own country. Only when that is not sustainable do they usually cross a border. And even then, they tend to remain in their region.

About 80% of all refugees—people who have fled conflict or persecution in their countries—are living in nations neighboring their nations of origin. Fewer than 1% of refugees are permanently resettled in foreign countries.

The majority of refugees I have met want to return home and resume their

PREVIOUS PAGE AND THIS PAGE: ILLUSTRATIONS BY JACQUI OAKLEY FOR TIME; THIS PAGE: MAP BY JING ZHANG FOR TIME



lives. But what if there is no longer a home to go back to? What if your home is underwater? If the island where your family and people have lived for centuries has sunk under the rising oceans? Whom do you turn to for help? What happens to your culture, your livelihood, your citizenship and your country's continued existence as a nation-state?

We are at a unique moment in history. As deserts advance, forests are felled, sea levels rise, and extreme weather events become more frequent and more destructive, we have a small window to identify the danger and work to bring order to chaos. There is a lot we can do to avert or help mitigate the worst-case scenarios: reduce emissions, and help countries adapt or prepare so people are not forced to leave their homes because of sudden disasters or slow-onset climate crises.

THE UNITED STATES should have a vital interest in helping to develop solutions. Our security is affected by global instability. And we have invested for generations in the development of poorer nations. Instead, the U.S. has declared its intention to withdraw from the Paris Agreement—likely denying us a seat at the table to influence and contribute to international decisions on these issues.

And in many countries, long-standing commitments to the legal rights and protection of refugees are being called into question. Climate-change effects increasingly interact with drivers of conflict, exacerbating refugee situations in countries like Chad, Sudan and Somalia. In such situations, refugee-law frameworks may apply. But ignoring our legal responsibilities toward refugees will only deepen human suffering and heighten global displacement. The new Global Compact on Refugees, adopted this year by the U.N. General Assembly, puts forward new international arrangements for sharing responsibility for refugees.

Because of rising seas, the family of Apisai Logaivau, including his son, Simione Botu, was relocated from their home in Vunidogoloa, Fiji

International cooperation will also be key to preventing, mitigating and resolving climate-related displacement. Many people displaced by climate change do not qualify as refugees, but how they are treated will affect the future stability of the world.

Tuvalu has called for a U.N. resolution to create a legal framework to protect the human rights and lives of migrants displaced by climate change. At a meeting in the country this summer, leaders from several Pacific islands reaffirmed their commitment to implementing the Paris Agreement and called on the international community to take urgent steps to keep warming below 1.5°C.

These nations view climate change as the single greatest threat to their populations. The urgent message from our most vulnerable nations should inspire the rest of the world to act. The Universal Declaration of Human Rights—the foundation of international human-rights law—makes clear that the rights of the citizen of a small island state, or a herder in a drought-affected part of Africa, rank equally with yours or mine. Yet in practice, they don't. It's a form of discrimination hardwired so deeply into our world that we are largely unaware of it.

While we in America do not face the imminent prospect of our entire homeland and culture drowning under surging seas, as many young *Pasifika,* or Pacific islanders, do, our country has a far bigger voice in decisions affecting the future of the environment than the people for whom this is already an existential question. Seen in this light, standing on the sidelines of global efforts is not a morally neutral position: it will negatively affect the lives of millions of people.

A nation of use only to itself is not a leading country. As Americans, we have rarely feared exercising our influence on global questions affecting the peace and security of the world as well as our own prosperity. A changing climate should be no different. In the past, America has been a country defined by vision. That still must be our greatest asset.

Jolie, a TIME contributing editor, is an Academy Award–winning actor and special envoy of the U.N. High Commissioner for Refugees

MA JUN

If China wants to lead, it must hold businesses accountable for emissions

CHINA IS THE WORLD'S most populous country and the largest emitter of carbon. If it can meet its vast potential for emission reduction, it will play an enormous role in tackling global climate change. The signs have been good. After suffering severe smog in 2011, the product of years of rising coal consumption, the Chinese government initiated a massive national action plan: halting the growth of coal consumption, improving air quality and helping the country limit emissions overall.

However, the economic slowdown and worsening trade war are risking a relapse. Some smog-stricken regions in China were found to have relaxed tight controls on polluting industries such as steel and cement in the second half of 2018, contributing to a rebound of smog last winter. The carbon market, the government's primary climate-action plan, has been significantly downsized while coal consumption picked up again last year.

So what can China do now to stem emissions and remain a leader in the fight against climate change, while also maintaining socioeconomic development? Tap into the power of the market, from the bottom up.

AS THE WORLD'S manufacturing hub, China is in a unique position to change the course of global emissions. In most industrial sectors, 75% of greenhouse-gas emissions are produced from the supply chains. In a globalized world, this means China's emissions are generated to meet more than just its own rising demand. Research conducted by the Carbon Trust found that China is the world's largest emitter in the apparel sector, but 72% of those emissions are essentially the responsibility of companies overseas where the products are exported and sold.

Responsibility for this division between manufacturing and products comes down to the private sector. In 2018, we at the Institute of Public and Environmental Affairs (IPE) examined the climate actions of 118 IT and textile-industry brands sourcing from China to rank them by how green their supply-chain practices are. Apple and Nike tied for first place, and Chinese brands Lenovo and Huawei reached the top 30, but most brands did not take supply-chain carbon footprints into consideration. Barely any set supply-chain emission-reduction targets. Consequently, most of the top global brands may not be able to meet their climate commitments.

Thankfully, things are already changing. As China has expanded environmental transparency, some 70 multinational and local brands have applied the monitoring data compiled by IPE to motivate more than 8,000 suppliers to address regulatory violations. The country's commitment to environmental transparency can incentivize companies to mitigate supply-chain emissions. Open carbon data not only enables businesses to set effective targets but also permits the public and investors to identify which are using best practices and which are racking up regulatory violations. To hold companies accountable, the state must also instigate high penalties for failing to disclose or falsifying this information.

But those leading brands demonstrating responsible oversight of their supply chains show that the private sector can make significant contributions, even without those systems in place. As climate change worsens, government and businesses will need to work in tandem to break the global community out of its "business as usual" mind-set.

Ma is an environmentalist and director of the Institute of Public and Environmental Affairs, a Beijing-based NGO

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

MAKE SURE THEY'RE IN THE RIGHT CAR SEAT

NHTSA.gov/TheRightSeat

NHTSA ad COUNCIL

If You Purchased PROVIGIL®, NUVIGIL®* Or Generic Provigil® (MODAFINIL), A Class Action And A California Attorney General Settlement* Could Affect You

INFORMATION REGARDING CLASS ACTION SETTLEMENT

A proposed $65,877,600 settlement has been reached in a Class Action Lawsuit on behalf of consumers and third-party payors regarding the prescription drug Provigil® and its generic equivalent modafinil. The Class Action Lawsuit claims that Defendants violated state antitrust and consumer protection laws by delaying the availability of less expensive generic versions of Provigil®. Defendants deny any wrongdoing.

No one is claiming that Provigil® or its generic equivalent modafinil is unsafe or ineffective.

Who Is Included?

You are a Consumer Class Member if you are:

- In Alabama, Arizona, California, District of Columbia, Florida, Hawaii, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, Nevada, New Mexico, New York, North Carolina, North Dakota, South Dakota, Tennessee, Utah, Vermont, West Virginia and Wisconsin, and you
- Purchased Provigil® or modafinil (e.g., by paying the full purchase price or a co-payment)
- For consumption by yourself or your family
- From June 24, 2006 through August 8, 2019.

You are **NOT** a class member even if you satisfy the above criteria if you were also insured and paid a flat co-pay that was the same dollar amount for generic as for brand drug purchases, or were insured and purchased only generic modafinil pursuant to a fixed co-pay applicable to generic drugs. In addition, employees of the defendants are not class members.

Please note that consumers may file a claim in this case even if the consumer previously participated and recovered money in the earlier State Attorneys General Settlement concerning Provigil®.

What Does The Class Action Settlement Provide?

The defendants will pay $65,877,600 into a Settlement Fund to settle all claims in the lawsuit brought on behalf of consumers and health insurers (known as third-party payors). The Settlement Fund will be distributed pursuant to a Plan of Allocation that can be reviewed at www.ProvigilSettlement.com.

Class Counsel will ask the Court to award attorneys' fees in an amount not to exceed one-third of the Settlement Fund, plus interest, litigation expenses and incentive payments to the Class Representatives. After these deductions, the remainder of the Settlement Fund will be distributed pro rata to Class Members who file a valid claim form. The consumer portion of the settlement fund will equal approximately $20,000,000, before deductions for fees and expenses. The precise amount that you might receive from the net settlement fund will depend on how much you (and other consumers) paid for Provigil® and modafinil.

How Do I Get A Payment?

You must submit a Claim Form by January 15, 2020 to be eligible for a payment. You can obtain a Claim Form by visiting www.ProvigilSettlement.com or calling 1-877-241-7503.

What Are My Other Rights?

If you do not want to be legally bound by the Settlements, you must exclude yourself. The exclusion deadline is December 6, 2019. If you do not exclude yourself, you will not be able to sue the defendants for any claim relating to the lawsuit. If you stay in the Class, you may object to the Settlements by January 15, 2020. Please review the requirements for exclusion and objection by visiting www.ProvigilSettlement.com or calling 1-877-241-7503.

The Court will hold a hearing on February 26, 2020 at 10:00 a.m. Eastern Standard Time to consider whether to approve the Settlements, counsel's request for attorneys' fees, expenses and incentive awards, any objections, and any other issues related to the Settlements. The Court has appointed Kessler Topaz Meltzer & Check, LLP, Spector Roseman & Kodroff, P.C. and Criden & Love, P.A. to represent the Class. Although not required, you or your own lawyer may ask to appear and speak at the hearing at your own expense. All deadlines may be amended by the Court, so please check the website noted below for updates.

INFORMATION REGARDING CALIFORNIA ATTORNEY GENERAL SETTLEMENT

***CALIFORNIA RESIDENTS**: You may also be eligible to claim from the CALIFORNIA ATTORNEY GENERAL'S $69,000,000 proposed settlement for purchases of Provigil®, NUVIGIL®, or modafinil, of which $25,250,000 will be available to eligible California consumers even if they have already recovered money from other related settlements. See www.ProvigilSettlement.com/CA for more information. You may recover for an eligible claim in both the California Attorney General Settlement and the Class Action Settlement described above.

FOR MORE INFORMATION AND A CLAIM FORM:
VISIT WWW.PROVIGILSETTLEMENT.COM OR CALL 1-877-241-7503.

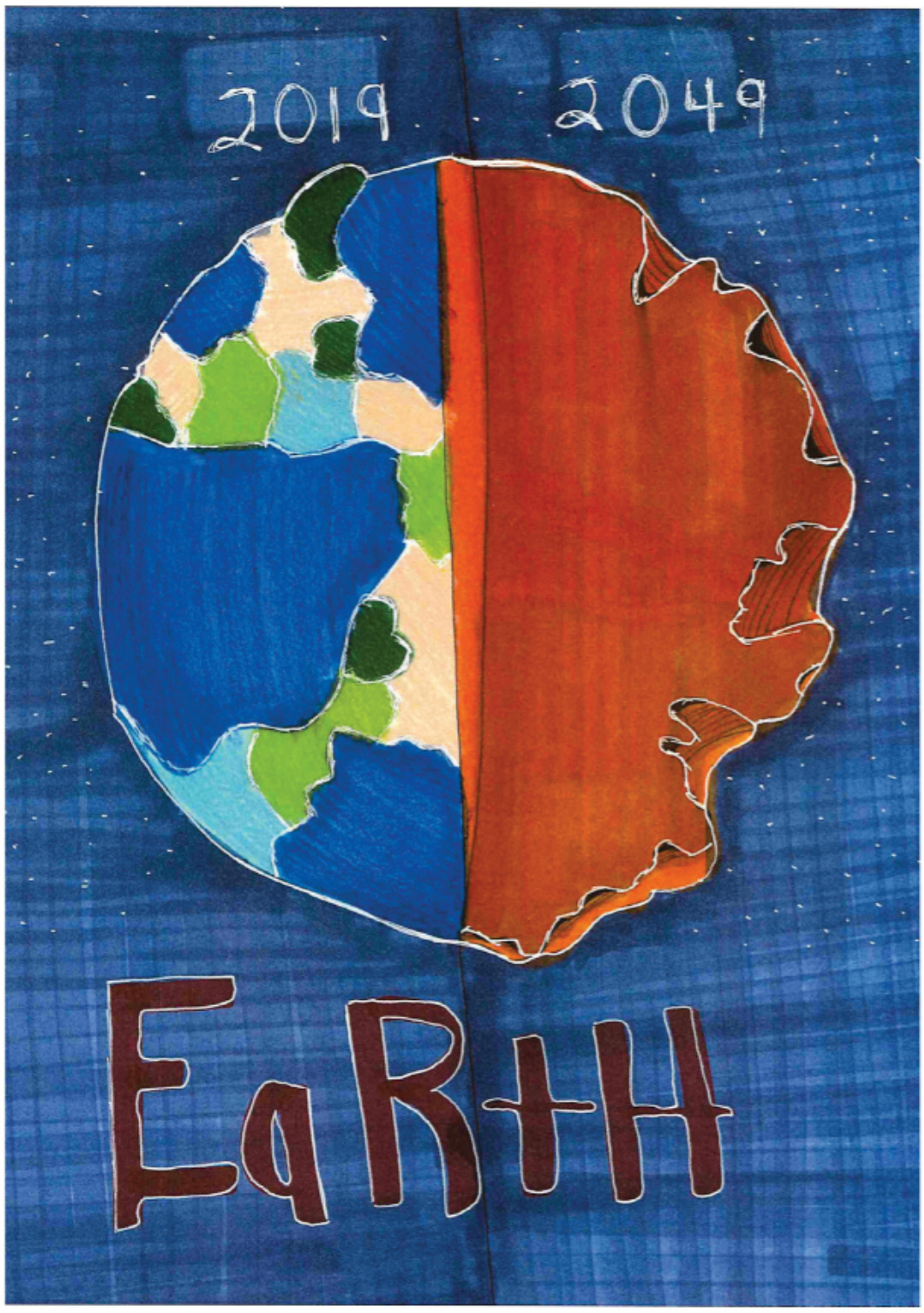
Kid's-Eye *View*

Children's art answers the question: What will earth look like in 30 years?

By Andrea Delbanco

"WE HUMANS NEED to do better." That's the sentiment Nahzeer Sandets, 12, shared in response to the question above. His drawing, at right, illustrates his bleak outlook on earth's future, and he's not alone—the environment, the fate of animals, and the perils to our planet consume the thoughts and imaginations of the next generation. TIME for Kids, the weekly classroom edition produced by TIME editors, asked young students to draw their view of the planet 30 years from now. Their art, a sampling of which is shown here, depicts a full spectrum of childlike outrage, fear and optimism. And while their anxiety arcs through the art in the form of angry suns and barren land, they also pour their passion onto the page. And that passion gives us hope—in the future, the artists will be the people in charge.

Delbanco is the editor-in-chief of TIME for Kids



NAHZEER S. AGE 12, CHICAGO

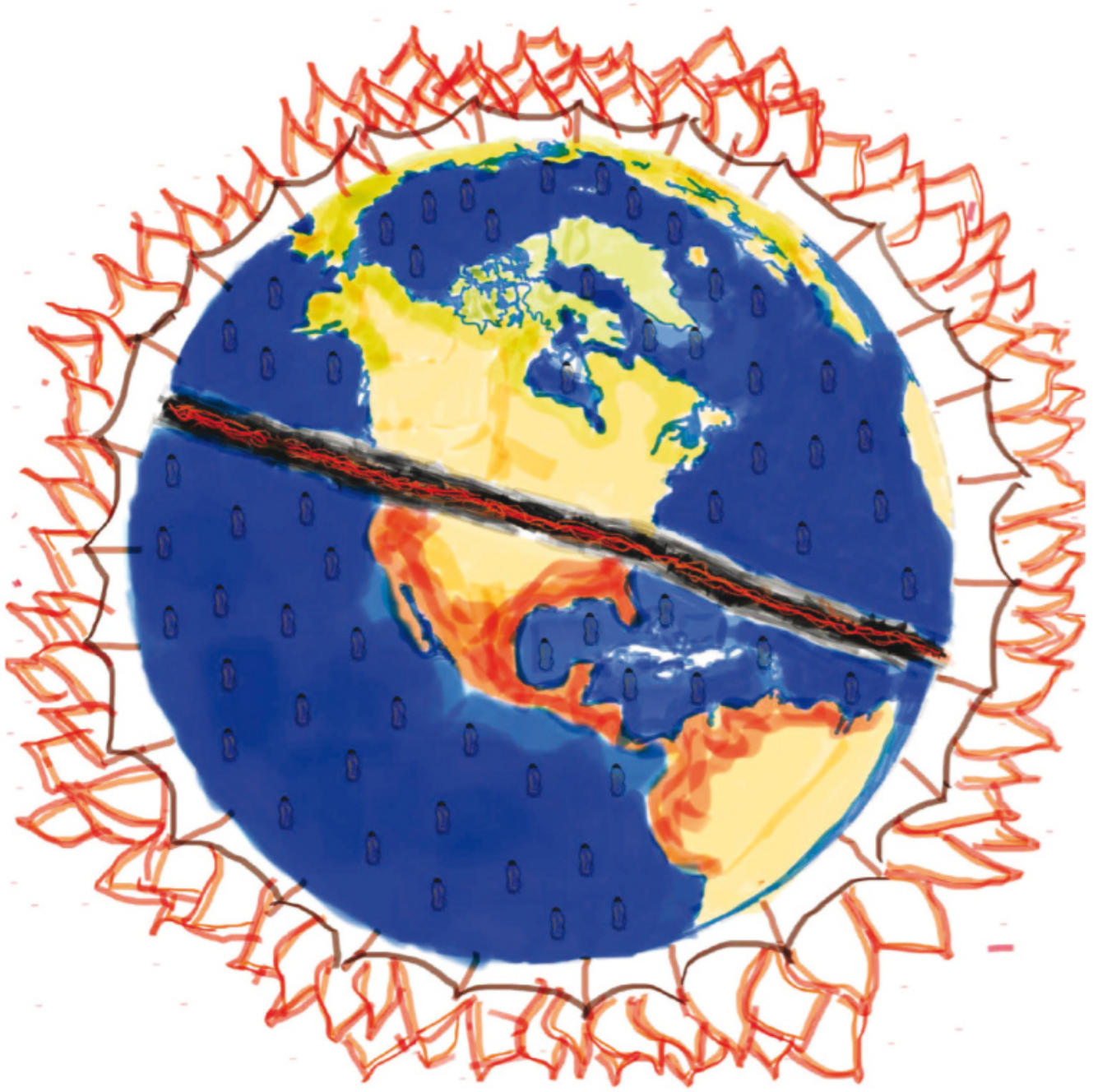
ELLA S. AGE 8, CHARLOTTE, N.C.

SARAH A. AGE 17, PARIS

WILLIAM L. AGE 14, SYDNEY

HAYDEN B. AGE 8, SUMMIT, N.J.

ALEXANDRA A. AGE 9, MIAMI



ZOLAIKHA B. AGE 9, CAPE TOWN

CLIMATE OPTIMISTS

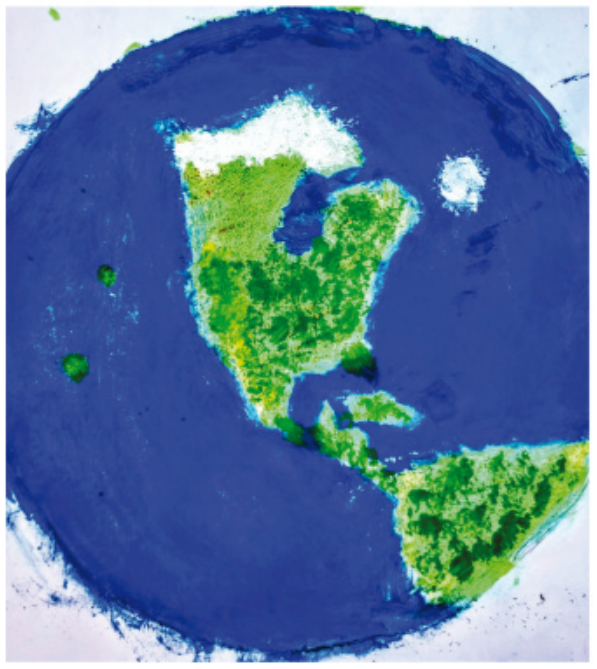
Katharine Wilkinson

EDUCATION

Author, public speaker and teacher Katharine Wilkinson has been passionate about protecting the planet since she went on an outdoor retreat 20 years ago as a high school student in North Carolina. “I went from loving the outdoors … to feeling incredibly convicted about how much work there was to be done,” she says. In 2017, the book *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* became a best seller. Wilkinson was the primary author. One of her guiding principles is the need to shift the climate-change discourse to “be more courageous and more emotionally intelligent,” she says, and the book is “about moving through what is hard and continuing to rise to the challenge.” Wilkinson recently co-hosted her own outdoor retreat, the Feminist Climate Renaissance, bringing together women from across sectors. “The climate crisis is also a leadership crisis,” she says, “and many women and girls are stepping in to fill that void and lead us forward … in a way that has not been the status quo in the climate movement.”

—Suyin Haynes

ILLUSTRATION BY JACQUI OAKLEY FOR TIME



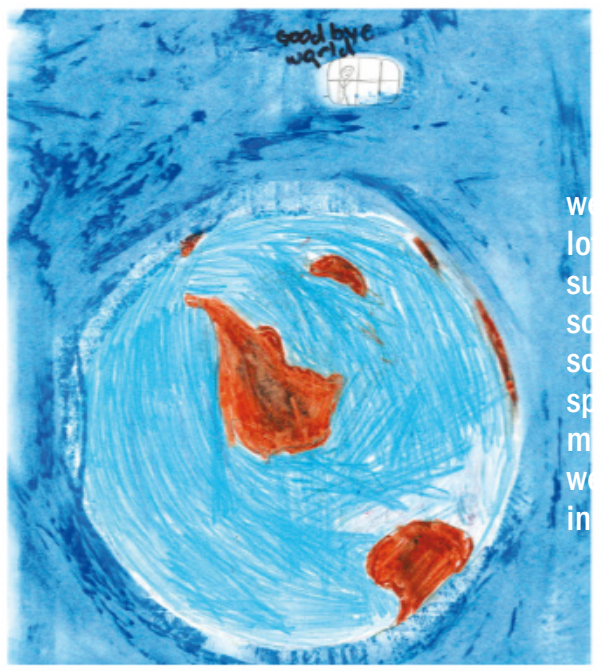
DYLAN L. AGE 8, QUEENS, N.Y.

MIRA W. AGE 10, LOS ANGELES

ROSA G. AGE 8, MORGANTOWN, W.VA.

'I drew half beautiful and half full of rubbish ... because how our world will be in 2050 is in our hands.'

AANYA C. AGE 6, HONG KONG

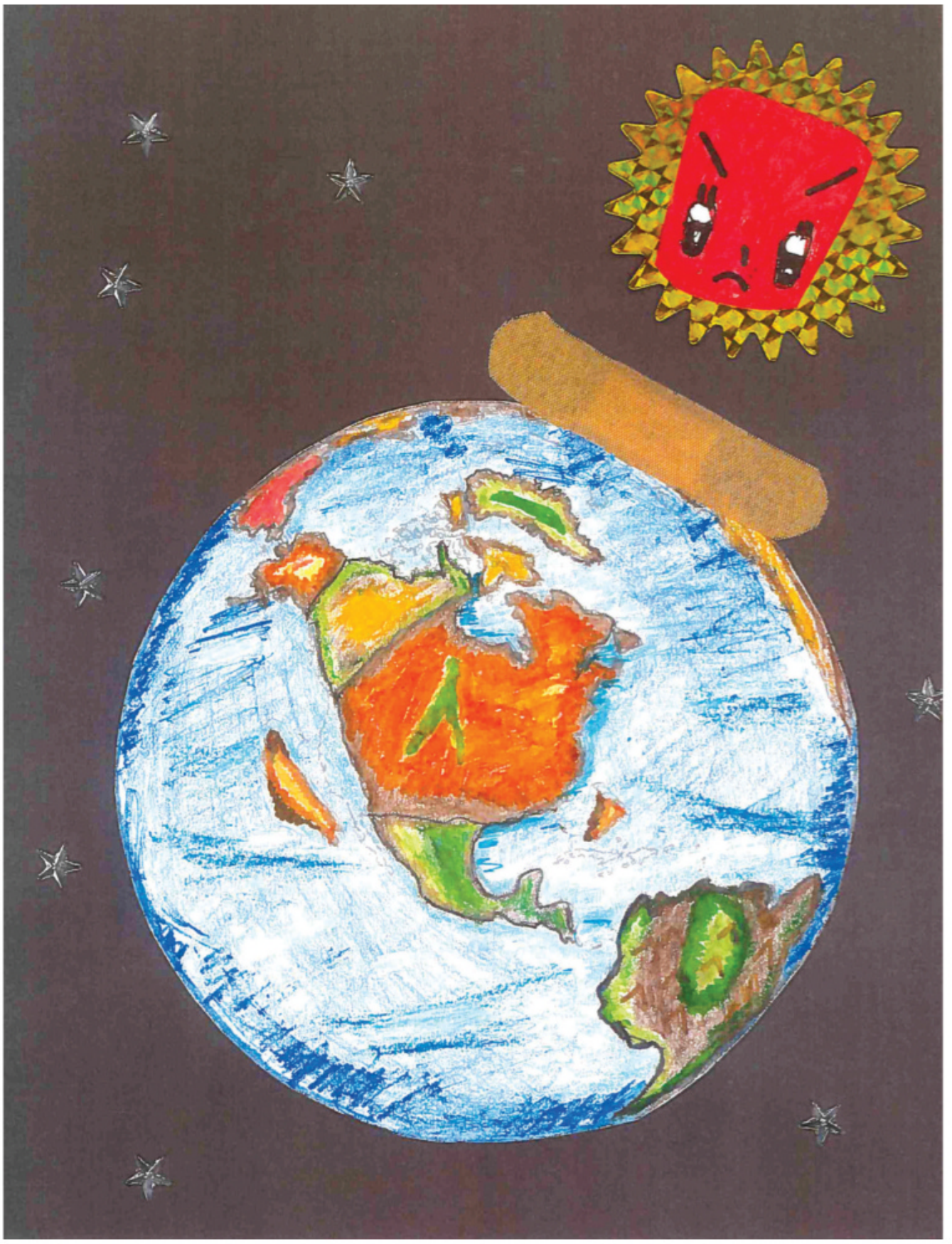


PELÉ P. AGE 10, MAPLEWOOD, N.J.

FIONN C. AGE 6, NEWRY, IRELAND

ZOË R.L. AGE 12, BROOKLYN

MIU B. AGE 8, NARA, JAPAN



'If the ocean gets too high, then small islands will disappear.'

KELLIE K. AGE 8, BROOKLYN

CLIMATE OPTIMISTS

Kate Marvel

SCIENCE

In blog posts, tweets and podcasts, Kate Marvel cuts through misinformation about climate change with storytelling. "I don't see doing science and talking about the science as mutually exclusive things," she says. In 2013, as a postdoctoral researcher with the Lawrence Livermore National Laboratory, Marvel helped discover that human activity has almost definitely changed global rainfall patterns. Today she's an associate research scientist at the NASA Goddard Institute for Space Studies at Columbia University, where she recently partnered with colleagues to study climate models and tree rings, and discovered that climate change has been affecting drought since 1900. Her approach to dealing with climate change might be best summed up in her 2017 TED talk on the currently unknown impact clouds could have on the future of global weather. "We don't know for sure what the future holds. But we are sending our kids there, and they are never coming back," she said. "I want them to be prepared for what they'll face."

—Jasmine Aguilera

ILLUSTRATION BY JACQUI OAKLEY FOR TIME

Two bad ideas for green energy

By Randall Munroe

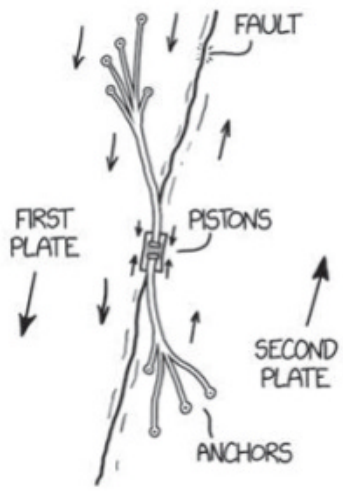
RANDALL MUNROE IS A CARTOONIST, AUTHOR, ENGINEER, SCIENTIFIC THEORIST AND THE CREATOR OF THE web comic *xkcd*. Below are two tongue-in-cheek proposals for new ways to generate emissions-free energy—both are clearly not viable, but perhaps they'll inspire someone to come up with something better. After all, we need all the ideas we can muster if we're to reach zero emissions. —ELIJAH WOLFSON

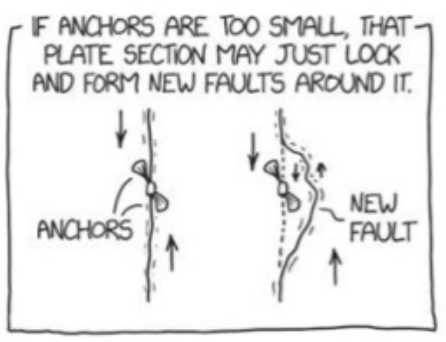
Tectonic plates

The ground exerts a force over a distance, and that equals energy. An inch of movement a year isn't much, but it has a virtually infinite force. Could you harness it to generate electricity?

In theory, yes!

Suppose you built a pair of giant pistons on two sides of a fault line created by two areas of crust sliding past each other. As, say, southward- and northward-moving pistons approached each other, they could compress a reservoir of fluid between them.





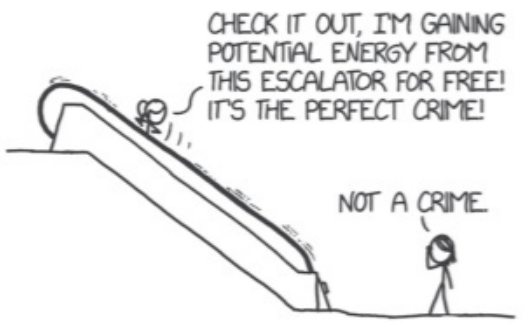
The pressure on the fluid would build up over time and could be used to drive a turbine. This whole system is ridiculous and technically infeasible for a lot of reasons. A big one is cost.

The "roots" of the structure that anchored the generator would need to extend outward a great distance to enlist a lot of crust. Too small an area of crust might just be locked in place by the generator, causing new fault lines to crack around it. Of course, size presents problems. If the roots were made of steel and extended 5 km in each direction, they would weigh 60 billion tons and cost around $40 billion.

BUT EVERYTHING AFTER THE FIRST 36 MILLION YEARS IS JUST MONEY IN THE BANK!
DON'T YOU HAVE TO KEEP BUYING LAND BECAUSE YOURS IS MIGRATING NORTH?
HEY, YOU GOTTA SPEND MONEY TO MAKE MONEY.

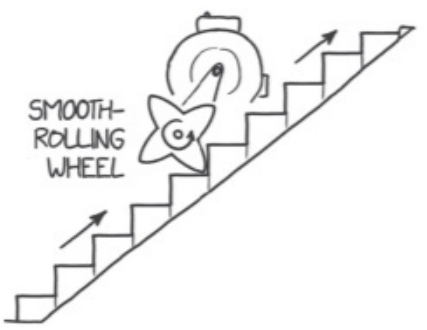
That's a lot of money, but you'd be saving about $1,100 per year on energy costs, so you'd make your money back in ... 36 million years.

Escalators



Escalators give energy to their riders. When you get on an escalator and start moving upward, the escalator consumes extra electrical energy to turn the motors that lift you. This energy is transferred to you in the form of potential energy. If you turn around and slide down the railing back to the lower level, you'll arrive at high speed—having turned the potential energy from the escalator motors, which you got for free from the escalator, into kinetic energy.

With the help of some simple mechanisms, you can turn that potential energy into electrical energy instead. Escalators are really just big metal waterfalls, and you can use the moving stairs to turn an axle, just like a waterfall turning a waterwheel at a mill.



A simple wheel with flat paddles will interlock awkwardly with the escalator. You can make it work more smoothly by building a wheel with curved paddles that mesh with the escalator. If you shape the paddles carefully, the wheel can stay in constant contact with the escalator without sliding.

The amount of power you can extract from an escalator this way can be substantial. The mechanical work an escalator does each minute is simple to calculate—it's equal to the peak number of passengers per minute times weight per passenger times the escalator's height times the acceleration of gravity. When fully loaded with people, a two-story escalator might easily output 10 kilowatts of mechanical power, much of which you could capture with a well-designed wheel. That's enough to run an entire house.

An escalator waterwheel could extract significant amounts of energy, but that also means it would cost the escalator owners significant amounts of money. If you force an escalator to exert an extra 10 kilowatts of power for 12 hours a day, that could cost the owners more than $400 a month extra in electricity bills. Needless to say, they probably won't be thrilled if they find out.

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ANDREW BLUM

Can we innovate our way out of this mess?

IN THE 1970S, the U.S. Department of Energy poured money into making practical a miraculous technology: the ability to convert sunlight into electricity. Solar energy was a pipe dream, far too expensive and unreliable to be considered a practical power source. But yesterday's moon shot is today's reality. The expense of solar power has fallen more quickly than expected, with installations costing about 80% less today than a decade ago. Alternative energy (like wind and solar) is now often cheaper than conventional energy (like coal and gas). Last year, California generated 19% of its electricity from solar power, up from less than 1% just 10 years earlier. That growth is global. Solar-energy production worldwide has increased nearly 2,000% since 2009, but the U.S. is far from the leader. Of approximately 100 gigawatts of solar generation added in 2018, China accounted for 44 and the U.S. 11.

Eliminating the carbon emitted in the production of electricity is a crucial step toward keeping the world from heating to dire levels. It is also among the most straightforward, largely thanks to the innovations of the past few decades, which were driven by a combination of ingenuity, research funding and policy incentives. Innovation is not enough to avert the worst consequences of climate change, but there are solutions at hand that are commonplace and cost-effective. We desperately need more. Here's a look at the things engineers have checked off their list, and the sticky problems left to solve.

TODAY'S RENEWABLES: SOLAR AND WIND

The decline in the cost of solar and wind power over the past decade has transformed the energy industry. Wind capacity in the U.S. has doubled over the past 10 years and is expected to double again by 2030. Solar power is growing even faster, with total installed capacity expected to double by 2024. Together, the two technologies have helped renewables leap from 9% of the U.S.'s electricity generation in 2008 to about 17% in 2018. Ongoing research and development is leading to continuous gains in how much power they produce. Wind operators are using artificial intelligence and improved weather forecasts to position their turbines for better performance, while solar-panel manufacturers are refining the use of new materials and processes to generate more electricity from smaller panels and drive down costs.

IMPROVING THE GRID: INTERCONNECTION AND STORAGE

In 2019, Nevada and Washington joined California and Hawaii in committing to 100% carbon-free electricity in the next generation. Around the world, France, Sweden, Norway, Portugal and the U.K., among others, have set similar goals. Achieving that with solar and wind power alone is tricky because of their "intermittency"—the times when the sun doesn't shine and the wind doesn't blow. One solution is to improve the ability to move energy from where it's produced to where it's consumed by building new power lines, known as interconnectors, that can move energy across long distances between regional power grids. Another is to store excess energy for later use, using batteries. Lithium-ion cells—used in mobile phones and electric cars—are the best energy-storage technology we have right now, and their use both in homes and alongside power plants is expected to grow storage capacity tenfold by 2024. While the current storage technology works best for less than four hours, engineers are developing novel alternatives that can store energy for longer periods of time. A startup in Switzerland called Energy Vault uses surplus electricity gathered on windy days to stack large bricks into towers with automated cranes, then recaptures the kinetic energy generated when the bricks fall back to the ground. Other companies are storing electrical energy as heat in molten salt or pumping water into reservoirs for later use as hydropower.

NEXT-GENERATION NUCLEAR

Nuclear reactors have been providing zero-carbon power since the 1950s, and today supply 20% of the U.S.'s electricity and 11% of the globe's. But safety and environmental concerns have increased the cost and complexity of nuclear power plants, and their construction has all but stopped in the U.S. (Only one new reactor has come online this century.) One strategy for reinvigorating the industry is to focus on smaller, simpler reactors that can be constructed in factories, produce less radioactive waste and require less day-to-day management. (Some will be designed to shut down automatically in case of disaster.) TerraPower, a Bellevue, Wash.–based startup with backing from Bill Gates, is one of several companies aiming for commercial use in the next decade. Another, Terrestrial Energy, in Canada, is developing a design that uses molten salt to produce 195 megawatts per reactor, about one-fifth of conventional units.

But some scientists are looking even further into the future, with novel technologies. Commonwealth Fusion Systems, a startup in Cambridge, Mass., is working to use new superconducting materials to build a fusion power plant—one that creates energy by combining atoms rather than dividing them, as in traditional nuclear. The project could take decades to fully commercialize but has the potential to revolutionize electricity.

MANAGING CARBON: SEQUESTRATION

Almost all the scenarios outlined by scientists to limit the increase in global temperatures require not merely reducing the amount of carbon emitted into the atmosphere, but eliminating it. The technology to do that, known as carbon capture and sequestration, involves removing carbon from the atmosphere and either physically storing it, often underground, or leveraging natural processes that capture and store it, as trees do. Engineers have been working on the challenge for decades, but costs remain high—in part because there is no economic benefit to storing carbon.

One way to change that would be to reuse the carbon as fuel, but that only delays its release; another would be a price on carbon itself. For engineers, it is a tantalizing area of research—the ultimate moon shot—because any breakthrough in capturing carbon, reusing carbon or storing it at a large scale would mitigate the potential catastrophe of allowing it to continue to heat the atmosphere. Life could not only go on—it could go on more or less as it has.

Blum is the author of The Weather Machine: A Journey Inside the Forecast

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

ADRIENNE L. HOLLIS

Climate change is the global health emergency of the 21st century

THERE CAN BE no discussion about climate change without a meaningful conversation about public health. As leading health experts have affirmed, the climate crisis is a threat multiplier, particularly for communities suffering from environmental injustice. For example, the Fourth National Climate Assessment, published in 2018 by a collaboration among 13 U.S. scientific agencies, highlights how higher temperatures, severe weather events and rising seas can contribute to heat-related cardiopulmonary illness, infectious disease and mental-health issues. Societal factors such as poverty, discrimination, access to health care and pre-existing health conditions make some populations even more vulnerable.

Thousands of communities nationwide—often low-income or with many residents of color—that already face environmental risks constantly grapple with issues that others seldom encounter with the same intensity. These include exposure to air pollutants (like particulate matter and soot produced from burning fossil fuels) or soil and water contamination (caused by dumping coal ash or lead in the water supply). These same communities tend to be systematically targeted when corporations and regulators decide where to build hazardous-waste sites, power plants and waste incinerators. It doesn't help that these populations often lack access to fresh produce, health insurance, affordable homes, public transportation and economic opportunities.

CLIMATE CHANGE IS a public-health issue. It has been linked to chronic conditions, such as kidney disease, depression and chronic obstructive pulmonary disease, and can shove the body's response to existing environmental assaults into overdrive. For example, people with asthma often experience more attacks during extreme heat and cold weather. As climate change continues to alter disease patterns and disrupt health systems, its effect on human health will become harder to ignore.

A recent report by the Union of Concerned Scientists found that climate change is poised to increase extreme heat significantly in frequency and severity, leading to more public-health risks across the U.S. In the U.S., urban communities of color, often also low-income areas, are especially at risk, particularly those living in counties in the Southeast, which have the highest concentration of African Americans. The situation is similar for Latinx populations. In the U.S. and globally, those least responsible for climate change are already the first to bear the brunt of its health effects. Low-income communities often do not have the resources to voluntarily evacuate during extreme weather events. In addition, economic and mental-health consequences abound when communities are displaced by environmental disasters.

We need policy changes that drive a just transition to a clean-energy economy and protect vulnerable communities from the impacts of climate change. At-risk communities should be given access to economical renewable energy; programs for affordable, climate-friendly heating or cooling options; and strong resilience measures to better cope with climate impacts. This, coupled with an ongoing honest dialogue and a principled partnership between decisionmakers and vulnerable populations, is fundamental to move forward toward a better, safer world as we work to tackle the mounting climate crisis.

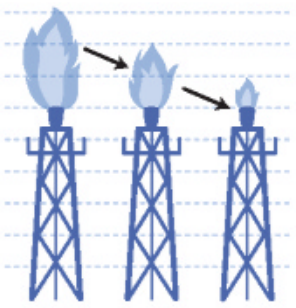
Hollis, Ph.D., J.D., is the lead climate-justice analyst at the Union of Concerned Scientists

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

A 30-year to-do list

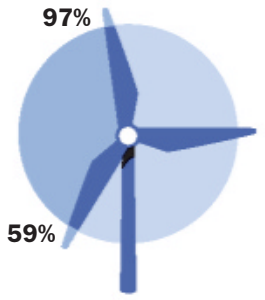
LAST YEAR'S LANDMARK REPORT FROM THE U.N. INTERGOVERNMENTAL PANEL on Climate Change issued dire warnings about the earth warming more than 1.5°C. The good news is that the IPCC also gave us a road map for tackling the problem. At time.com/one.five, you can sign up for our climate newsletter, One.Five, to get periodic updates on how the world is progressing to meet each of these goals. —JUSTIN WORLAND

Phase out natural gas and eliminate coal



Natural-gas use likely needs to **decline by at least 13% and as much as 62% by 2050;** coal needs to all but disappear as an electricity source by 2050, with the fossil fuel representing no more than a few percentage points of global energy

Grow renewables

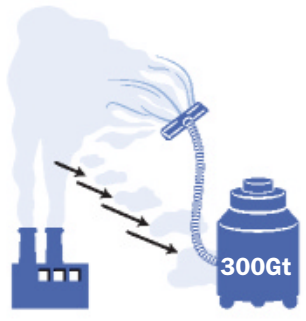


Renewables like wind and solar need to make up **at least 59% and as much as 97% of total electricity** by 2050; electricity needs to account for more of total energy, especially for industry and transport

Chart a path on nuclear

Nuclear could provide as much as **28% of electricity by 2050—or as little as 1%;** energy experts continue to debate whether the zero-carbon electricity it provides is worth the challenges of nuclear waste and other risks

Remove carbon from the atmosphere



Humans have emitted so much CO_2 that we'll likely need to take some out of the atmosphere to meet targets: if we move quickly away from fossil fuels, we could avoid this; if we move slowly, we may need to capture as much as **300 gigatonnes of CO_2**—equivalent to more than 50 years of U.S. energy-related emissions

Change our agriculture and support trees

Global forest area cannot **shrink by more than 2 million sq km and may need to be increased by as much as 9.5 million sq km;** that means changing what we eat so we need less land for agriculture

Make our energy use more efficient

Greater efficiency—everything from better light bulbs to cars with better mileage—would help **reduce the need for investment in new energy sources by as much as 50%**

THIS ROAD MAP USES THE IPCC'S ANALYSIS OF VARIOUS SCENARIOS. THE RANGES CITED REPRESENT THE UPPER AND LOWER BOUNDS OF THE INTERQUARTILE RANGE OF SCENARIOS THAT HAVE A LOW CHANCE OF OVERSHOOTING THE 1.5°C TARGET.

HOW WE GET THERE

GOVERNMENT COMMITMENTS

1

Governments need new rules that prod widespread change in behavior and make polluting expensive or illegal

CORPORATE COMMITMENTS

2

An estimated $830 billion in additional annual investments could transform the way we use energy

INDIVIDUAL COMMITMENTS

3

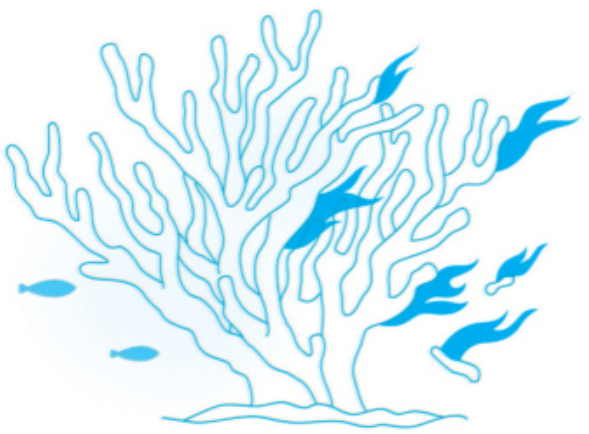
Individuals can change their behavior to cut emissions and push companies and government to change

ENCOURAGE INNOVATION

4

Technical advances will be crucial, from small steps like building better solar panels to new ways to capture carbon

ILLUSTRATIONS BY BROWN BIRD DESIGN FOR TIME



Great Barrier

By Barbara Kingsolver

The cathedral is burning. Absent flame or smoke,
stained glass explodes in silence, fractal scales
of angel damsel rainbow parrot. Charred beams
of blackened coral lie in heaps on the sacred floor,
white stones fallen from high places, spires collapsed
crushing sainted turtle and gargoyle octopus.

Something there is in my kind that cannot love
a reef, a tundra, a plain stone breast of desert, ever
quite enough. A tree perhaps, once recomposed
as splendid furniture. A forest after the whole of it
is planed to posts and beams and raised to a heaven
of earnest construction in the name of Our Lady.

All Paris stood on the bridges to watch her burning,
believing a thing this old, this large and beautiful
must be holy and cannot be lost. And coral temples
older than Charlemagne suffocate unattended,
bleach and bleed from the eye, the centered heart.

Lord of leaves and fishes, lead me across this great divide.
Teach me how to love the sacred places, not as one
devotes to One who made me in his image and is bound
to love me back. I mean as a body loves its microbial skin,
the worm its nape of loam, all secret otherness forgiven.

Love beyond anything I will ever make of it.

Kingsolver is the author of 15 books, including a forthcoming book of poetry

ILLUSTRATION BY HARRY CAMPBELL FOR TIME

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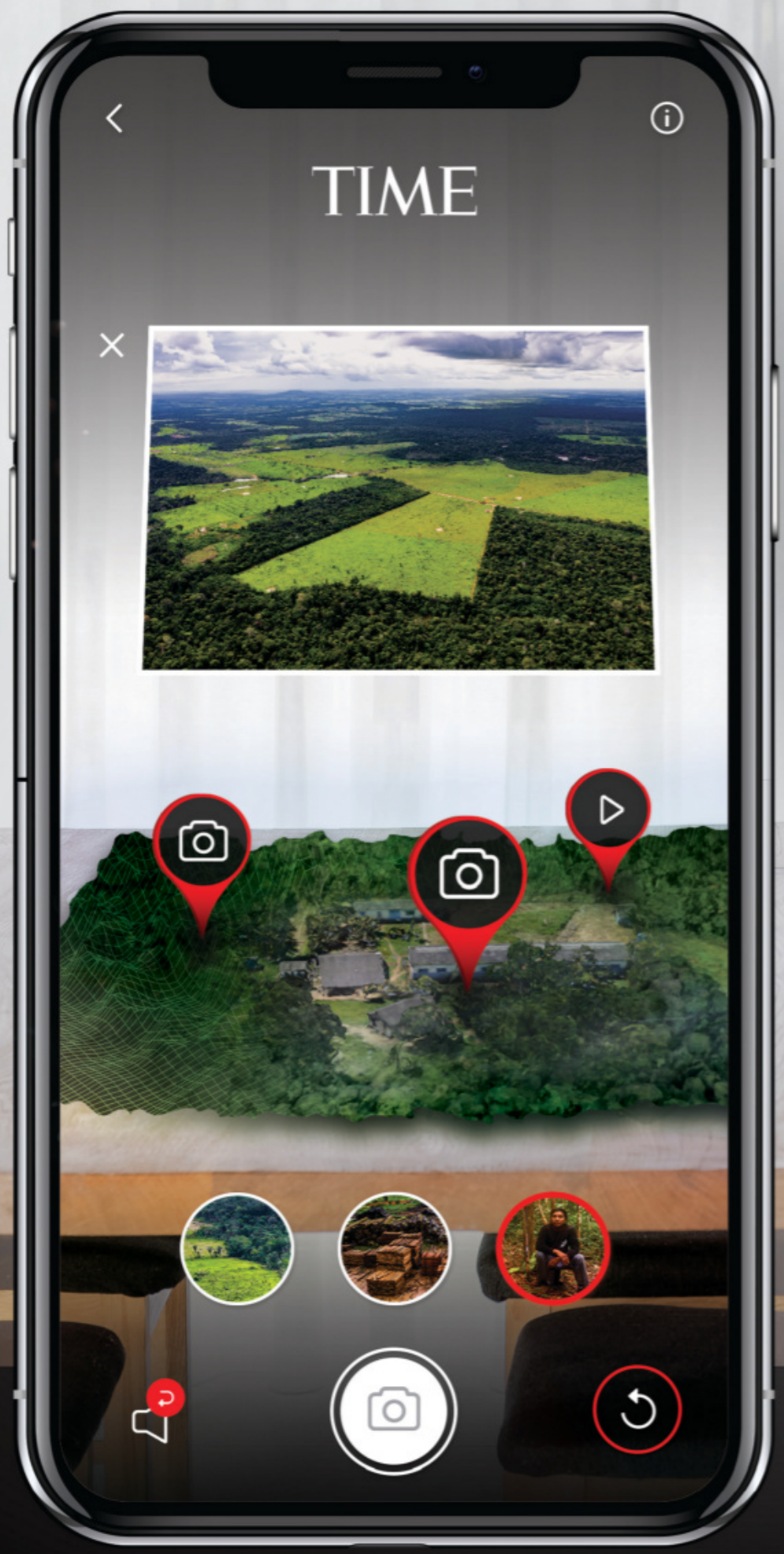

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